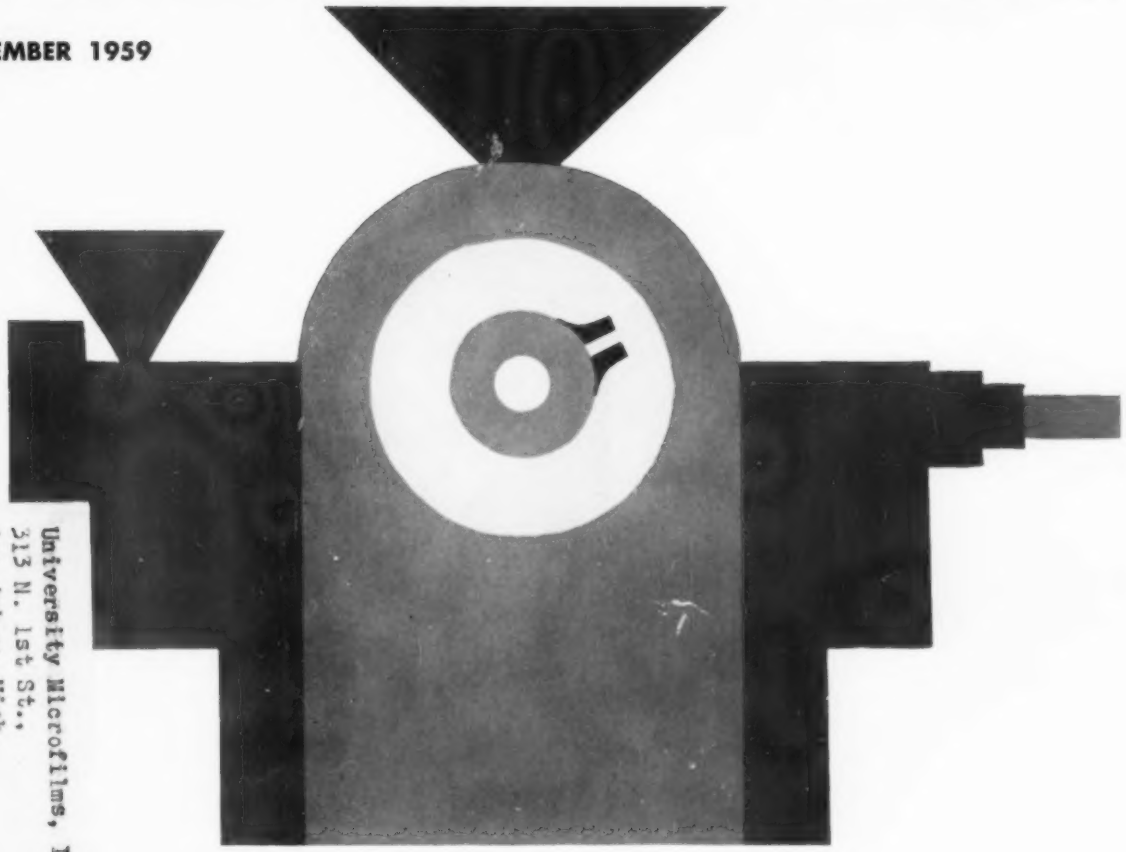
# PLASTICS

THE MAGAZINE OF APPLIED ENGINEERING

# TECHNOLOGY

SEPTEMBER 1959



University Microfilms, Inc.,
313 N. 1st St.,
Ann Arbor, Mich.

59
F&E

## BUYERS' SPECIFICATIONS 1959

## EXTRUDERS .... AUXILIARIES & BLOW-MOLDING MACHINES

# *New!* EPON® RESIN 1002

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Now you can say good-by forever to the hot weather annoyance of having granular resin solidify in the bag. *Shell Chemical's new Epon resin 1002 will not sinter even when your workroom temperature crowds the 100 mark!*

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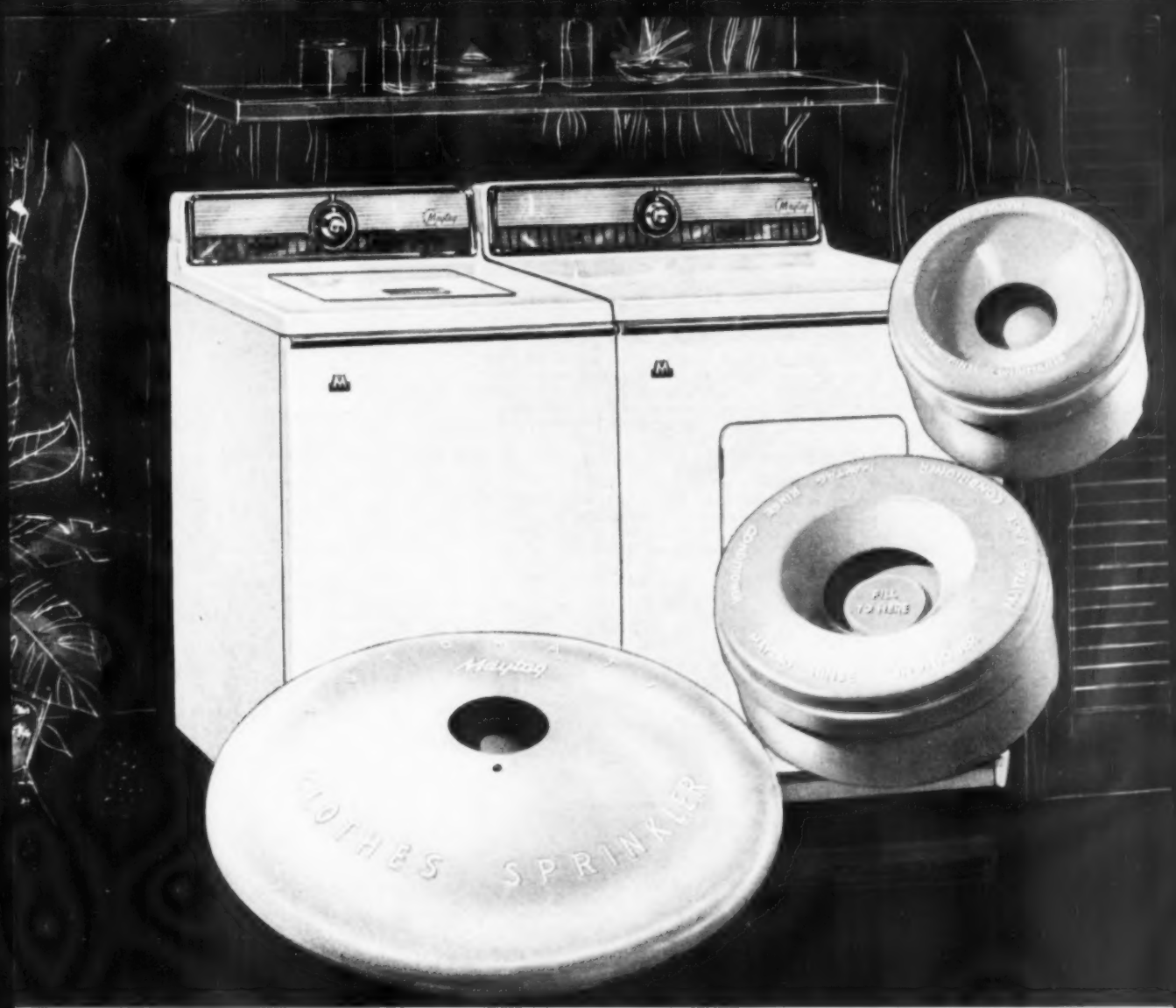


## For a long, rugged service life, these MAYTAG components are molded of

### HEAT RESISTANT – HIGH IMPACT *Catalin* STYRENE

MAYTAG, in engineering its handsome, new line of feature-packed automatic washers and dryers . . . developed an automatic clothes sprinkler and an automatic rinse conditioner that was a natural for plastics. After investigating and testing various compounds . . . their molder, Artag Plastics Corp., selected CATALIN Heat Resistant, High Impact STYRENE as the formulation that possessed all the properties necessary to meet Maytag's quality-standards.

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**TYPICAL PROPERTIES**

| | | |
|---|---|---|
| Tensile strength, psi., ⅛" bar | D638-52T | 5000-6200 |
| Elongation, % | D638-52T | 7.5-12.0 |
| Modulus in tension, x $10^5$, psi. | D638-52T | 4.0 |
| Impact strength, ⅛" bar, ft. lbs./in. of notch | D256-54T | 2.4-3.4 |
| Flexural strength, ⅛" bar, psi. | D790-49T | No failure |
| Heat distortion, °F., Annealed | D648-45T | |
| ½" x ½" bar | | 205 |
| ¼" x ½" bar | | 205 |
| ⅛" x ½" bar | | 203 |
| Flammability, ⅛" bar, in./min. | D635-44 | 1.1-1.3 |
| Rockwell hardness, "M" | D785-51 | 51 |
| Specific gravity | D792-50T | 1.04 |
| Dielectric constant, $10^6$ cycles | D150-54T | 2.5 |
| Dissipation factor, $10^6$ cycles | D150-54T | 0.0010-0.0015 |
| Thermal coefficient of expansion, in./in./°C. | D696-44 | 8-10 x $10^{-5}$ |

*Component parts custom molded for The Maytag Company by Artag Plastics Corporation, Chicago 18, Illinois*

**Catalin Corporation of America** Catalin **One Park Avenue, New York 16, N. Y.**

# PLASTICS

THE MAGAZINE OF APPLIED ENGINEERING

# TECHNOLOGY

September 1959, V. 5, No. 9



feature articles:

**measuring resilience of flexible urethane foams** ..... p. 55

by R. E. JONES, PAUL HERSCH, G. G. STIER and DR. B. A. DOMBROW

A study of foam resilience reveals the importance of two primary factors, polymeric creep and pneumatic damping, which may govern resilience of foam cushions. Each factor is shown to be dependent on conditions both inherent in the foam and the method of measurement. A simple, yet accurate, apparatus is described for measuring dynamic resilience.

**examining the heat-distortion behavior of plastics** ..... p. 60

by R. VAN CLEVE and R. R. COSNER

A new and improved test apparatus is described which will determine ASTM-type heat-distortion temperatures for plastics materials. In addition, the apparatus also indicates the slope of deflection versus time or temperature as an index of the degree of severity of failure at the heat-distortion point.

guest editorial:

**unfair competition** ..... p. 65

by A. R. MORSE

special features:

**what a plastics engineer should look for when planning to buy auxiliary equipment for extrusion** ..... p. 67

by R. E. MONICA

Factors that should be considered carefully when selecting auxiliary equipment for the individual extrusion plant include hopper loaders, hoppers, ovens, control panels and controllers, scrap grinders, and suitable take-away equipment. This last category can involve flat sheet extrusion, plastic pipe extrusion, extruded shapes, film extrusion, plastic monofilament, wire coating, and blow molding. Proper planning includes thought on what the equipment must accomplish, as well as its flexibility, maintenance, safety, and cost.

**pt's comparative data on 1959 extrusion machines** ..... p. 73
(Based on data submitted by the machine manufacturers)

**pt's comparative data on 1959 blow-molding machines** ..... p. 80
(Based on data submitted by the machine manufacturers)

**pt's classified list of auxiliary equipment for extrusion and blow-molding** ..... p. 77

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Introduction to Reinforced (Impact) Phenolics

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**silicone resins** ..... p. 86

by L. J. ZUKOR

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Achievement Awards in Processing
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Cover: Courtesy of Dow Corning Corporation


Opinions expressed by contributors do not necessarily reflect those of our editors



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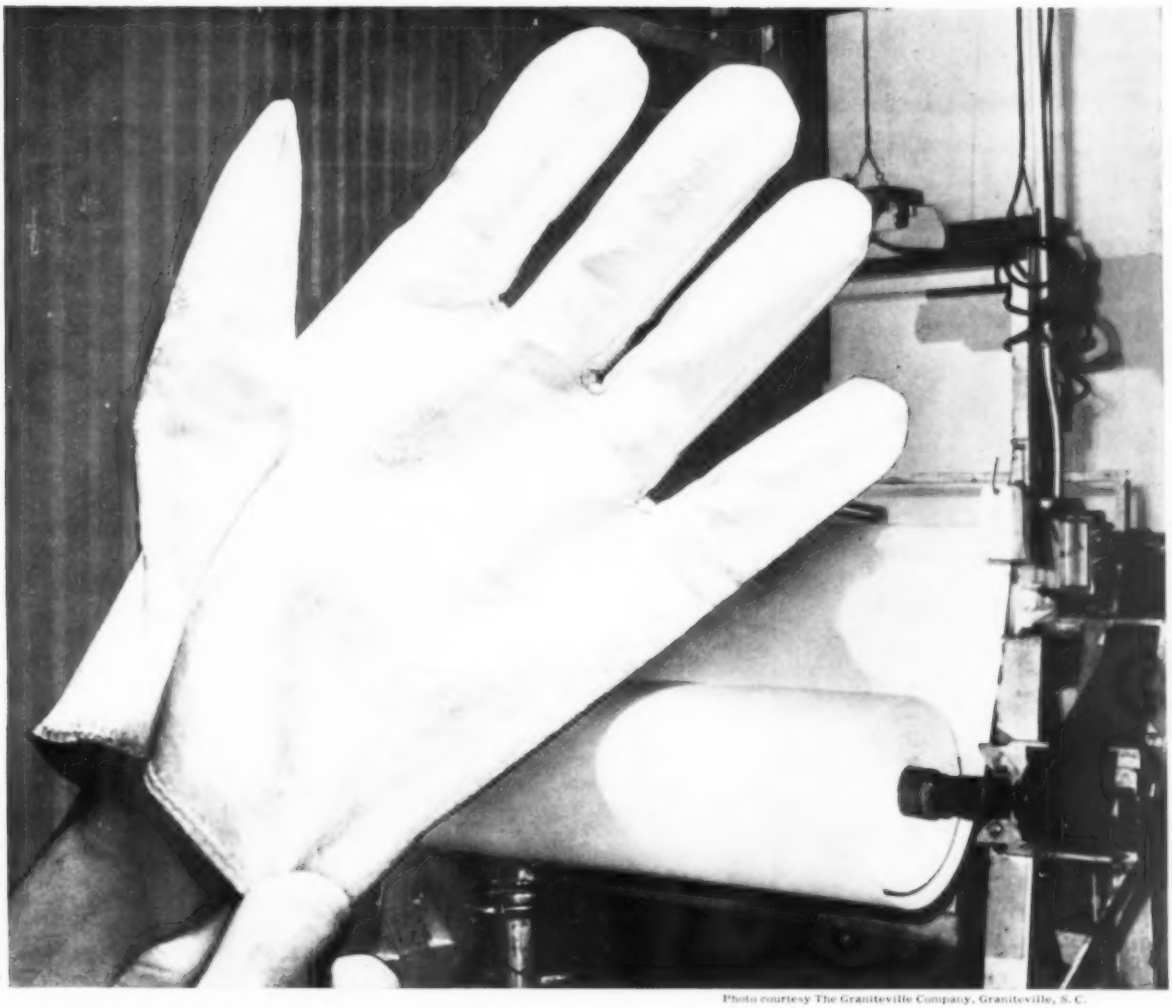

Photo courtesy The Graniteville Company, Graniteville, S. C.

# It gives gloves better "hand"

**Looks like suede**—feels like suede—but the work glove above is actually made of cotton. What gives this glove its unique suede-like appearance and better "hand"? Answer: it was knife-coated with a compound based on PLIOVIC AO, Goodyear vinyl chloride copolymer dispersion resin.

**In addition** to its distinctive texture, this new material will wear three to four times longer than uncoated fabrics and has exceptional "gripping power." Called Duro-Suede, it is now being produced for work gloves —may soon be used in work shirts and jackets, sports clothing and various industrial applications.

**PLIOVIC AO was chosen** for its low fusing temperature, excellent plasticizer compatibility, good viscosity characteristics and film texture. All of these properties contribute to ease of processing, efficient operation and outstanding product quality.

**Want to add** sales-building new properties to your product? PLIOVIC AO may help you do it. Write for complete information—including latest *Tech Book Bulletins*—to: Goodyear, Chemical Division, Dept. 1-9441, Akron 16, Ohio.

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# Letters to the Editors

### An Article Author Complains

Dear Sir:

It is inevitable that articles for publication need some editorial changes before final printing. Some of those made to my article in the June issue are understandable.

However, it is unfortunate that all the figures could not be included in the paper as their omission detracts somewhat from the story that is presented in the text. We also note that the change in title, to which I called your attention in my letter of April 30, was not incorporated. As you may recall, we made this change in order better to fit the article as brought up to date. Included in the paper are data on other than polyester plastics.

The article as published, although distinctly less complete than the original paper, still contains one paragraph which is completely meaningless in view of the omissions in figures made; on page 43, the paragraph beginning at the end of the first column with "Results of 24-months exposure . . ."

It would have been most desirable to have had a chance to approve these changes before publication.

*A. L. Smith, Head of Devel. & Appls. Lab. for Reinforced Plastics, Rohm & Haas Co., Bristol, Pa.*

*(We print Mr. Smith's letter and our reply to answer similar questions from article authors, past, present, and future.*

*The omitted material would have taken another page at least, plus several large figures. Space is a primary consideration for any publication, and our reviewers agreed with the changes and condensations made in the original manuscript. Since more than 90% of the paper dealt with polyester plastics, the suggested change in the title of the published article was not made after serious consideration of the idea.*

*By virtue of experience, we know that every author becomes an editor when given the opportunity to polish up his own paper. As such, we do not send him galley proofs or page proofs unless we and the reviewers find an insoluble problem that requires clarification from the author. Any changes in the proofs, even an amended comma, cost money —so we try to avoid casting temptations before our authors! —Editor)*

### Erratum, non factum

Dear Sir:

I wish to thank you for inserting the announcement regarding Pelron's expansion in your April issue. I would like to call your attention to the fact, however, that you misspelled the name of our company. Any correction of this matter would be greatly appreciated.

*Paul E. Pelletier, President*
*Pelron Corp.*
*Lyons, Ill.*

*(We're sorry. They're just not making those typewriters like they used to anymore.—Editor)*

• • •

### Information Wanted

Dear Sir:

We are interested in locating sources of the necessary materials for making small, molded plastic articles which can be packaged in a do-it-yourself or hobby kit. The essential requirements of the material are that it be simple to handle, suitable for home-craft use without any machinery or experience.

Our idea is to package this material in kit form with suitable plaster molds so that hobbyists can cast their own plastic articles. The basic material should be clear but compatible with coloring agents which can be mixed with the material before casting.

Any information that you may be able to give us will be greatly appreciated.

*M. M. Vorenberg*
*Bags'n Bangels*
*Palm Beach, Fla.*

*(Interested parties are invited to answer the inquirer either directly or through this office for transmittal. —Editor)*

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

## PREVIEWS

## of Next Month

The October issue will feature the following articles:

**Mold Design for Premix.** H. J. Duprez, Project Engr., Plastics Dept., Wallace & Tiernan, Inc., Belleville, N. J.

By comparing standard design techniques used to make molds for molding premix materials, it is possible to visualize the tooling advantages found with these materials. Mold design and fabrication techniques are described for molding at a cost consistent with production rate and volume requirements for the moldings.

•

**A Study of Compression Molding Pressures.** D. A. Dearle, Plastics Div. Mgr., North & Judd Mfg. Co., New Britain, Conn.

Excessive or inadequate molding pressures can affect the suitability of the resulting molded parts and the life durability of the compression presses themselves. The problems involved with the major types of compression presses are described, and the use of pressure accumulators is discussed. Equations and their use in calculating the proper pressures are given.

•

**Thermoforming Biaxially-Oriented Film and Sheet.** J. L. Murphy, Mgr. of Tech. Service, Ultron Calendered Products, Plastics Division, Monsanto Chemical Co., Springfield, Mass.

Dominant variables that contribute to improper vacuum forming of oriented sheet and film include sheet clamping, heat equalization, mold temperature, cycle timing, drape speed, and adequate vacuum. The importance of each factor is described, and information given on recent developments in forming equipment and product design.

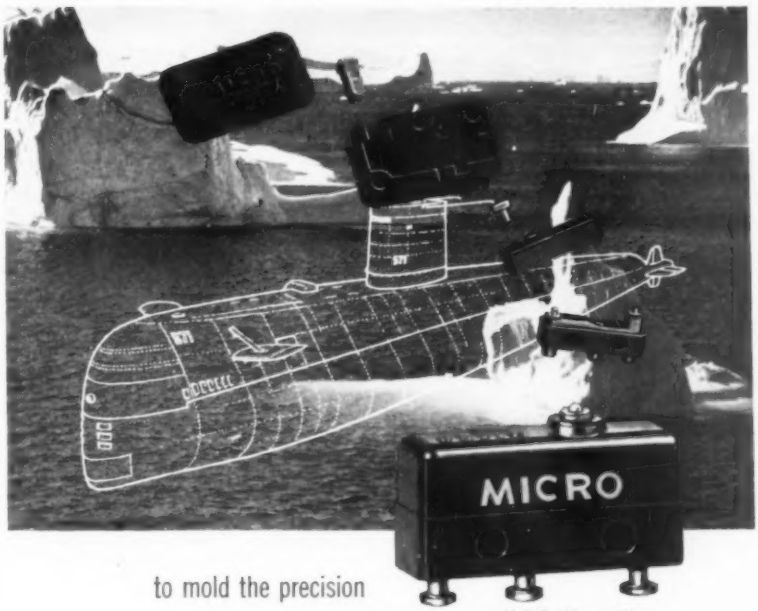
•

**Effects of Molding Variables on Reinforced-Plastic Products.** T. H. Beals, Chemist, T. G. Tan, Chem. Engr., and C. B. Sias, Director, Research & Development Center, Pittsburgh Plate Glass Company, Springdale, Penna.

In an extensive series of tests made on glass-polyester parts made in matched metal molds, the most important variables readily controllable by the molder were found to be the styrene content of the resin, the resin reactivity, and the molding temperature. The best-appearing moldings tested were cured at 260° F., using the highest-reactivity resin (70% maleic) at the 25% styrene content level.


IF PHENOLICS CAN DO IT, **PLENCO** CAN PROVIDE IT

AND DOES—FOR **MICRO SWITCH**




to mold the precision switches used aboard the **USS Nautilus,**

Minneapolis-Honeywell's **MICRO SWITCH** division specified

**PLENCO**

THE HAZARDS that exist for underwater Arctic seamen at the top of the world are many.

A conventional magnetic compass, for example, is unreliable and useless as an instrument for indicating direction in that area. Yet, the atomic powered USS Nautilus, in its historic first transpolar crossing, was able to avoid the danger of unknown position or track. Aboard were MICRO SWITCH subminiature switches, part of the Controls System of the most advanced navigational equipment available.

So incredibly precise are these subminiature switches that the movement required to actuate them is as slight as *thirty-thousandths* of an inch. Assured dimensional stability of switch housings, covers and components, under the most adverse conditions of exposure and physical abuse, is therefore vital. For such assurance, MICRO SWITCH engineers specify high-strength Plenco phenolic compounds.

In the molding of these elements of the miniaturized switches, as well as those of the larger limit switches, Plenco molding compounds meet the specified requirements—minimum moisture absorption; maximum dielectric strength; and, of course dimensional stability. All contribute to the proved reliability of MICRO SWITCH precision snap-action switches in the Controls Systems of industrial installations everywhere.

Through scrupulous quality standards and an extensive selection of general and special-purpose compounds, Plenco contributes similarly to many other industries. We'd like the opportunity to apply them to *your* product or production problem.

PLENCO PHENOLICS
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**PLASTICS ENGINEERING COMPANY**

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Serving the plastics industry in the manufacture of high grade phenolic molding compounds, industrial resins and coating resins.

Despite the best of care...

# Who hasn't had some troubles with vacuum metallizing?

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We've had our share. Because Bee's Logo Division produces a greater variety of coatings for vacuum metallizing, on more materials, for a greater range of end uses, than any other manufacturer.

We've had to come up with solutions to problems involving resinous base coatings used on plastics, metals or glass—each presenting specific production difficulties. Top coatings, clear, opaque or in color, are separate problems. Our answers involve coatings that bake or air dry in minutes, speeding production, increasing capacity, cutting costs.

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**Here's a new booklet jam-packed with helpful information about vacuum metallizing coatings . . .**

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# What's New in Processing

Beginning with this issue we shall attempt to correlate all of the "back of the book" news and data on processing, bringing it up front as a separate column. This includes patents on processing, abstracts of both domestic and foreign articles on the subject, short news items concerning a new or improved process, books covering the topic, and any company literature wherein a process is described.

•

**Armour Research Foundation** of Illinois Institute of Technology reports that processing a commercial plastic such as polystyrene in an electric field, at the same time subjecting it to external heating increases the tensile strength by about 25%. Other materials are being tested, and ARF scientists feel that such mechanical properties as elasticity and tear strength could be improved by the same method.

•

**R. F. Plastics Co.,** Arlington, Mass., has developed a method of treating fluorocarbons (Teflon and Kel-F) to assure bondability. Called F.S.P., the process involves a vapor blast of the surface followed by a chemical etch at controlled temperatures and chemical concentrations. When storage and handling contamination problems exist before bonding, a high-temperature polymer coating is applied to the areas to be bonded. This coating is said to eliminate corona problems.

•

Recent processing patents include J. A. Greenhoe's to Monsanto on a method for producing porous films from a PVC plastisol containing water as the blowing agent—**2,864,777.** The water is added to the polymer and plasticizer before extenuating it into a thin film and heating to fusion.

Fritz Stastny to Badische Anilin on forming articles from porous styrene which would have impact-resistant surfaces—**2,865,800.** Here, the inner surface of a gas-permeable mold is partially covered with an unsaturated polyester and liquid vinyl followed by a second layer of expandable styrene. Heating brings on polymerization and fusion.

G. Guzzetta to Montecatini on coating iron with polyethylene—**2,866,718.** The surface is flame-sprayed with powdered polyvinyl formal to give a wrinkle coating, then with powdered polyethylene heated to liquefaction.

•

The April, 1958 issue of Plastverarbeiter carried an article on the **"Injection Molding of Hostalen,"** by A. Schley and A. Fischer. Optimum molding conditions were described along with properties affecting processing such as flow, shrinkage, and warping.

Poliplasti, May-June, 1958 featured an article by P. Bonardi entitled **"The Use of Polyester Resins as Encapsulating Materials."** Techniques were reviewed.

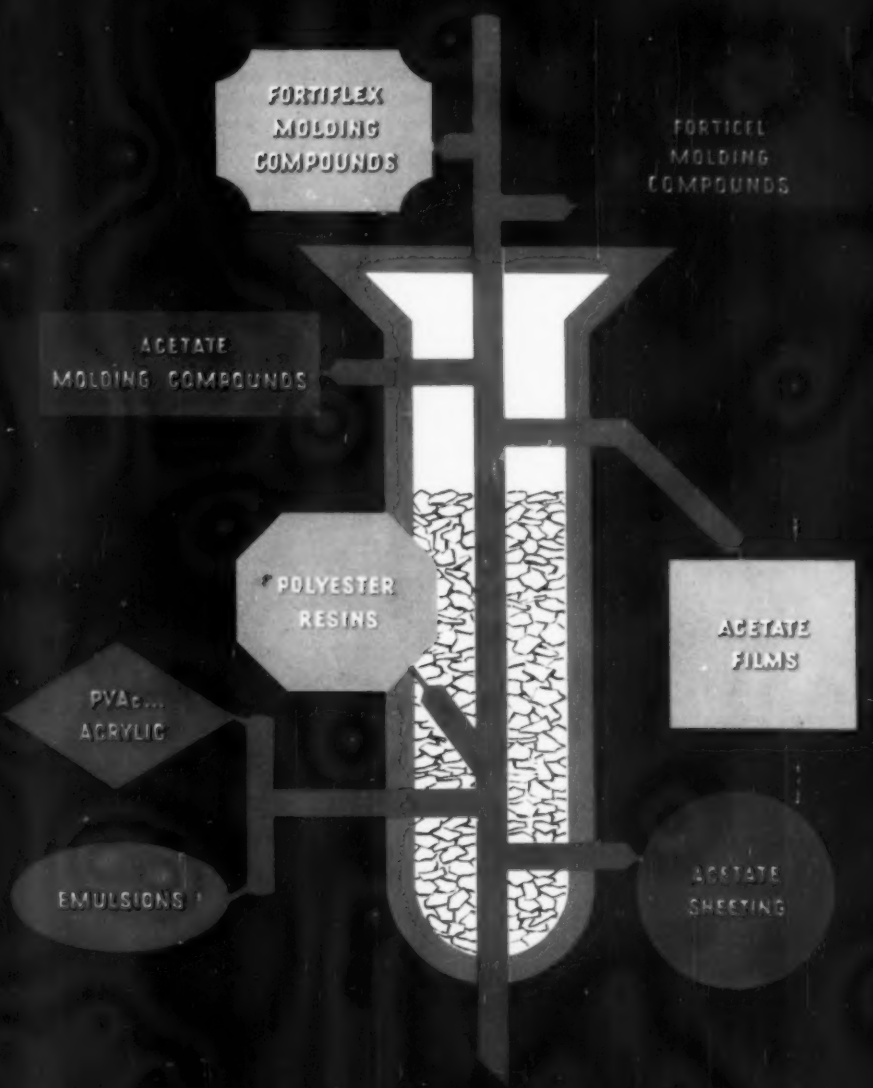
February, 1959 British Plastics ran an article on **"Rotational Casting of PVC Pastes,"** by A. C. Measey. Principles of the method were given together with a description of the equipment and molds involved.

**"Electroforming"** by R. J. Jonke described the process as it concerned the making of molds for the plastics industry. Industrie Plastiques Modernes, February, 1959.

Rubber & Plastics Age ran an article by E. Gaspar entitled **"Developments in Injection Molding"** in its December issue, 1958. Mold locking and injection mechanisms, pre-plasticization, molds and temperature control are described.

John R. Kent described **"Thin-Wall Injection Molding"** in the August, 1959, issue of Plastics World. Problems encountered are described in some detail. A check list is included enumerating the problems and points to check when encountering them.

**"Injection Molding FEP Fluorocarbon Resin"** is described in the August issue of Modern Plastics by H. Larsen, G. DeHoff, and N. Todd. The effects of molding conditions on properties are given, and it is pointed out that the shear rate of the flowing melt should not exceed the critical shear rate.




Celanese

# PLASTICS

# FORTIFLEX . . . A high-density,

Fortiflex A is a series of linear polyolefins, produced by a low-temperature, low-pressure method. The high crystallinity of Fortiflex A (93% compared to 65% for conventional polyethylene) results in superior physical properties. Fortiflex A is a rigid, tough, heat-resistant thermoplastic. Molded parts can be sterilized at temperatures up to 250°F. Fortiflex A can be molded with relative ease into parts having a lustrous finish and good chemical resistance. The material has extremely low permeability to liquids and gases, and its tensile properties are excellent.

Fortiflex A is available in both natural and colored molding powders. Five formulations provide a wide flow range:

**FORTIFLEX A-20** possesses the highest impact strength, stress cracking resistance and low-temperature strength of the series. It requires somewhat higher process temperatures. Recommended for extrusion, calendering, blow molding, or injection molding of very small parts requiring maximum physical properties.

**FORTIFLEX A-70** is a general-purpose resin. Recommended for injection molding of small parts with limited surface area. This resin is also suggested for extrusion, calendering, blow molding and as a rubber compounding additive.

**FORTIFLEX A-250** is used for intermediate-sized injection molded articles where better moldability and improved surface finish are required. Also suited for the extrusion of film.

**FORTIFLEX A-500** possesses the best moldability for large-area moldings and applications where maximum processability is required.

**FORTIFLEX A-800** is designed primarily for use as a blending component with conventional polyethylene. It offers substantially improved flow characteristics and has reduced impact strength as compared to other resins in the Fortiflex A series. It is suggested for use in blends, single-use containers, or items requiring low

## PHYSICAL PROPERTIES RELATED TO MELT INDEX

| Property | Units | ASTM Method | A-20 | A-70 | A-250 | A-500 | A-800 | B50-20 | B50-80 to B50-500 |
|---|---|---|---|---|---|---|---|---|---|
| Melt Index | — | D1238-52T | 0.2 | 0.7 | 2.5 | 5.0 | 8.0 | 0.2 | 0.8-5.0 |
| Heat-Distortion Temp., 66 psi. | °F. | D648-56 | 185 | 185 | 180 | 180 | 180 | 170-175 | 170-175 |
| Impact Strength[1], Notched Izod[2] | ft. lb./ in. notch | D256-54T | 23 | 18 | 13 | 3 | 0.7 | 7 | 5-1 |
| Tensile Strength, 0.2 in./min.[3] | psi. | D638-52T | 3700 | 3600 | 3500 | 3300 | 3300 | 3200 | 3100 |
| Elongation, 0.2 in./min.[3] | % | D638-52T | 28 | 25 | 18 | 13 | 13 | 30 | 25-18 |
| Environmental Stress Cracking Resistance, $F_{50}$ Value | hr. | Bell Lab.[4] | 190 | 30 | 6 | 3 | — | 2000 | (5) |

## PHYSICAL PROPERTIES NOT RELATED TO MELT INDEX

| Property | Unit | ASTM Method | Fortiflex A | Fortiflex B50 |
|---|---|---|---|---|
| Density | g/cc. | D792-50 | 0.96 | 0.95 |
| Highest Use Temperature[6] | | | | |
| Continuous | °F. | — | 180 | — |
| Intermittent | °F. | — | 225 | — |
| Softening Temperature[7] | °F. | — | 260 | 255 |
| Stiffness in Flexure | psi | D747-50 | 140000 | 100000 |
| Hardness | Rockwell R | D785-51 | 40 | 40 |
| | Shore D | D676-49 | 65 | 64 |
| Mold Shrinkage[8] | | | | |
| Length | in./in. | — | 0.010-0.030 | 0.010-0.030 |
| Width | in./in. | — | 0.010-0.025 | 0.010-0.025 |
| Flammability | in./min. | D635-44 | 1.0 | 1.0 |
| Water Absorption, 24 hr. at 77°F. | % gain | D570-54T | < 0.01 | < 0.01 |
| Refractive Index | $n_D^{25}$ | D542-50 | 1.54 | 1.54 |

## TYPICAL ELECTRICAL PROPERTIES OF FORTIFLEX A AND FORTIFLEX B-50

| Property | Units | ASTM Method | Frequency (cycles per sec.) | Value |
|---|---|---|---|---|
| Dielectric Strength (short time) | volts/mil | D149-55T | — | 500 |
| Volume Resistivity | ohm cm. | D257-54T | — | $6 \times 10^{15}$ |
| Dielectric Constant | — | D150-54T | $1 \times 10^3$ | 2.35 |
| | | | $1 \times 10^6$ | 2.36 |
| Dissipation Factor | — | D150-54T | $1 \times 10^3$ | 0.0002 |
| | | | $1 \times 10^6$ | 0.0003 |
| Loss Factor | — | D150-54T | $1 \times 10^3$ | 0.0007 |
| | | | $1 \times 10^6$ | 0.0007 |

## GAS PERMEABILITY OF FORTIFLEX A

| Gas | Units | Value* |
|---|---|---|
| Carbon Dioxide | (cc. cm./sec. cm.$^2$ cm. Hg.) x $10^{-9}$ | 0.21 |
| Hydrogen | | 0.20 |
| Oxygen | | 0.07 |
| Helium | | 0.15 |
| Ethane | | 0.15 |
| Natural Gas (ca. 99% Methane) | | 0.07 |
| Freon | | 0.06 |

*Determined on 2 mil blown tubing by method of Baubaker and Kammermeyer, Ind. Eng. Chem. 45, 1148 (1953).

## CHEMICAL RESISTANCE OF FORTIFLEX A

| Chemical | Value* |
|---|---|
| **ACIDS** | |
| Acetic Acid, glacial | 0.7 |
| Oleic Acid | 0.7 |
| Sulfuric Acid 98% | 0.0 |
| Nitric Acid 70% | 0.3 |
| **BASES** | |
| Sodium Hydroxide 50% | 0.0 |
| Ammonium Hydroxide 28% | 0.0 |
| **SOLVENTS** | |
| Acetone | 0.7 |
| Carbon Tetrachloride | 14.0 |
| Ethanol | 0.1 |
| Ethyl Acetate | 2.3 |
| Methyl "Carbitol" | 0.1 |
| **MISCELLANEOUS** | |
| Water | 0.0 |
| Gasoline | 6.0 |
| Lubricating Oil | 0.6 |
| Brake Fluid | 0.2 |

*% Increase in wt. after 30 days immersion at 80°F. Sample specimens were 1"x¼"x⅛" 0.035.

### FOOTNOTES

(1) Impact values observed on injection molded bars should not be considered indicative of practical impact values for molded items where other factors affect the impact value. While its impact value will be sufficient for most uses, Fortiflex B should be evaluated for each specific application.

(2) Injection molded specimens, ⅛"x½" cross section, notch in the ⅛" face. A-20, A-70 and A-250 specimens did not break. A-500 and Fortiflex B50 copolymers exhibited partial or hinged breaks.

(3) Injection molded Type I specimens, ⅛" thick. Tensile strength and elongation data recorded at the first yield point.

(4) ASTM Standard on Plastics, Issue of February, 1957. Appendix, page 831 – Proposed Method of Test for Environmental Stress Cracking of Ethylene Plastics.

(5) Fortiflex B50-80 has an environmental stress cracking resistance $F_{50}$ value of 160 hrs.

(6) Highest use temperature depends on part design, molding and service conditions, special formulations are available for continuous use at higher temperatures up to 212°F.

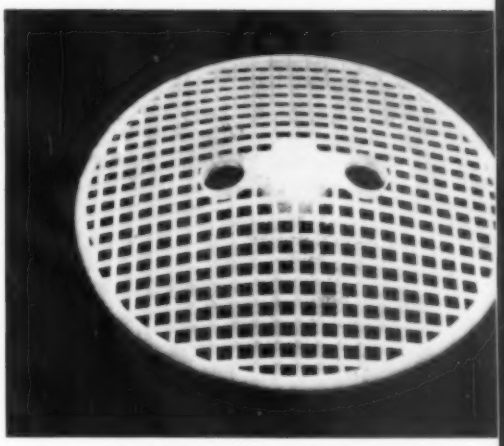
(7) Method of Karrer et al, Ind. Engr. Chem., Anal. Ed. 2, 96 (1930).

(8) Mold shrinkage depends on part design and molding conditions.

impact strength such as certain toys and novelties. Not recommended where stress cracking is a problem.

**FLAME RESISTANT FORTIFLEX.** In order to meet the increasing demand for flame resistant materials, Celanese is offering specially formulated variations of Fortiflex A-70, A-250 and A-500. These flame resistant Fortiflex formulations are opaque, self-extinguishing high-density polyethylenes with a specific gravity of 1.04. Their stiffness, hardness and tensile strength are approximately the same as the standard resins'. However, heat distortion values under 66 psi are slightly lower and impact strength is somewhat reduced. Burning rate or flammability is reduced to the point where they can be classified as non-burning materials under ASTM D-635-44.

Applications for Fortiflex A include: housewares and appliances, electrical and automotive parts, filaments for textiles and rope, packaging materials, bottles and containers, toys, industrial parts and protective helmets.



**LINT SCREEN** for gas and electric dryers has rigidity, toughness, heat resistance. Smooth, lustrous surface of Fortiflex handles laundry gently.

## FORTIFLEX B

Fortiflex B, a group of linear copolymers, is the latest in the Fortiflex family. It was developed to provide special advantages. With the addition of Fortiflex B, the Fortiflex series provides a family of resins with an extremely broad range of properties which make it possible to upgrade many applications now employing other thermoplastics while it also opens up many new fields of application for plastics.

Fortiflex B is an excellent injection molding plastic and provides outstanding stress crack resistance. Processability of Fortiflex B resins is somewhat improved over the Fortiflex A series resins when compared with them on a melt index for melt index basis. Thus, cycle time for a given part is somewhat less for these resins as compared to Fortiflex A, since their cold point and viscosity are lower. The improved flow properties result in faster fill and freeze times.

In tests under a static load, properly oriented filaments of the new polymer show reduced tendency to stretch. Under sustained stress they resist failure up to ten times longer than previous polyolefin filaments.

The Fortiflex B series is recommended for end-uses such as filaments for rope and outdoor furniture webbing, wire covering, blown bottles and containers, paper coating, film, and pipe.

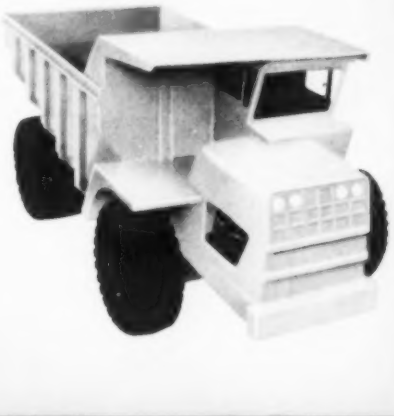
Possible applications for injection molding are: containers for stress-active agents, drum plugs, fittings and couplings, thin-walled moldings, large area moldings, insert moldings, bottle caps and closures.

New prospects for the blow molding of bottles and hollow-ware have been opened to molders by the Fortiflex B series.

**VACUUM-CLEANER HOSE** armored with Fortiflex filament is strong, light in weight, abrasion resistant. Filament has high tenacity, low elongation.

**COLORFUL HOUSEWARES** molded of Fortiflex have lustrous surface and high impact strength. They are rigid, tough, light in weight . . . withstand boiling heat and freezing cold.

**MASSIVE, HEAVY-DUTY DUMP TRUCK** molded of Fortiflex has high strength and rigidity. Large toy moldings and weight-bearing toys are made possible by Fortiflex.



**G. E. VAPORIZER** uses unbreakable, lightweight bottle which holds nearly a gallon of water. Fortiflex is an outstanding material for blow molding hollow shapes.

# FORTICEL cellulose propionate

Forticel is distinctive among thermoplastics for its excellent *balance* of desirable properties. Its combination of toughness and good flexural strength is unique among cellulose ester plastics. Moreover, the high impact strengths of Forticel occur at moderate plasticizer levels, where its other good characteristics, such as dimensional stability and stiffness, are also optimum. No other cellulose plastic of similar general properties has less humidity expansion. The low water absorption of Forticel results in stability against warpage. Forticel has considerably more resistance to weathering than cellulose acetate and is very similar to cellulose acetate butyrate in this respect.

Forticel is exceptional for the luster of its molded surface, which is obtainable on a fast cycle—in some items the fastest of all the cellulosics. A free flowing plastic, it can be injection molded with great ease and lends itself to restricted gating and complicated mold layouts. Its superior flow insures practically invisible weld lines where two streams of plastic meet in the die. Forticel eliminates problems of flow around mold pins. Finished parts of Forticel are free from objectionable odor, so that Forticel is often used for personal items such as mascara brushes and containers, toothbrushes, toys, and telephone headsets.

Forticel is produced in four series of formulas offering different flow ranges and end-use advantages. Forticel is available in a range of transparent, translucent and opaque colors. Applications include: pens, telephone housings, automotive parts, optical frames, business machine keys, vacuum cleaner attachments, handles, small equipment housings.

## CHEMICAL RESISTANCE*

| Reagent | Effect |
|---|---|
| **ACIDS** | |
| 30% Sulfuric | No change |
| 30% Sulfuric | No change |
| 10% Nitric | Surface attacked |
| 5% Acetic | No change |
| 10% Hydrochloric | No change |
| Oleic | No change |
| **BASES** | |
| 10% Sodium Hydroxide | Sl. surface attack |
| 1% Sodium Hydroxide | No change |
| 10% Ammonium Hydroxide | Sl. surface attack |
| 2% Sodium Carbonate | No change |
| **ORGANIC SOLVENTS** | |
| Carbon Tetrachloride | Swollen |
| Gasoline (white) | No change |
| **AQUEOUS SOLUTIONS** | |
| Water | No change |
| 10% Sodium Chloride | No change |
| 3% Hydrogen Peroxide | No change |

*ASTM method D-543

## ELECTRICAL PROPERTIES*

| | | |
|---|---|---|
| Dielectric Constant at $10^6$ cycles | D-150-54T | 3.0 to 3.5 |
| Power Factor at $10^3$ cycles | " | 0.010 to 0.011 |
| Power Factor at $10^6$ cycles | " | 0.017 to 0.020 |
| Insulation Resistance (megohms) | D-257-54T | $2 \times 10^4$ |
| Dielectric Strength (volts/mil) | D-149-55T | 800 to 1,500 |

*Measured at 73°F. and 50% R.H.

The electrical properties of Forticel are considerably more constant over a humidity range than those of cellulose acetate because of much lower water absorption.

## TYPICAL PHYSICAL PROPERTIES OF FORTICEL

| | | Flow Temperature | Specific Gravity | Rockwell Hardness | Impact Strength (Izod) | Heat Distortion Temp. | Tensile Strength | Elongation | Flexural Strength | Water Absorption | Molding Cold Point |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unit | °C | | R Scale | ft. lb./in. notch | °C | psi | % | psi | % | °F |
| | A.S.T.M. Test | D569-48 | D792-50 | D785-51 | D256-54T | D648-45T (264 psi) | D638-52T | D638-52T | D790-49T | D570-54T | Relative |
| JN SERIES | A-(H2) | 179 | 1.24 | 106 | 1.2 | 70 | 5,900 | 63 | 10,000 | 2.00 | 425 |
| | B-(H2) | 176 | 1.23 | 102 | 1.4 | 67 | 5,400 | 60 | 9,400 | 1.90 | 415 |
| | A-(H) | 174 | 1.22 | 97 | 1.6 | 65 | 4,900 | 55 | 8,900 | 1.80 | 405 |
| | B-(H) | 171 | 1.22 | 89 | 2.4 | 63 | 4,600 | 55 | 8,500 | 1.80 | 390 |
| | A-(MH) | 168 | 1.21 | 82 | 4.2 | 61 | 4,300 | 54 | 7,800 | 1.70 | 380 |
| | B-(M) | 165 | 1.20 | 70 | 8.5 | 59 | 3,900 | 54 | 6,600 | 1.70 | 360 |
| | A-(MS) | 162 | 1.20 | 62 | 10.5 | 57 | 3,500 | 54 | 6,200 | 1.70 | 340 |
| | B-(MS) | 159 | 1.19 | 53 | 10.8 | 56 | 3,300 | 53 | 5,800 | 1.70 | 325 |
| | A-(S) | 156 | 1.19 | 43 | 11 | 55 | 2,900 | 52 | 5,200 | 1.60 | 310 |
| | B-(S) | 153 | 1.19 | 33 | 11 | 53 | 2,600 | 51 | 4,500 | 1.60 | 295 |
| | A-(S2) | 150 | 1.19 | 21 | 11 | 52 | 2,400 | 50 | 4,000 | 1.60 | 280 |
| | A-(S3) | 145 | 1.18 | –15 | 10 | 51 | 1,900 | 48 | 3,000 | 1.60 | 260 |
| HL SERIES | A-(H2) | 183 | 1.24 | 100 | 1.7 | 70 | 5,400 | 50 | 10,000 | 2.00 | 420 |
| | B-(H2) | 178 | 1.23 | 95 | 2.0 | 69 | 5,000 | 56 | 9,600 | 1.80 | 405 |
| | A-(H) | 176 | 1.21 | 90 | 2.4 | 67 | 4,800 | 58 | 9,200 | 1.70 | 390 |

**TELEPHONES IN COLORS** add a bright touch to decor. Forticel provides shatterproof toughness, good dimensional stability, high surface luster.

**WESTCLOX "TRAVALARM"** comes in lustrous ivory or black. Forticel was selected for its toughness, excellent moldability, freedom from unpleasant odor.

**FAMOUS NAMES** in pens prefer strong Celanese Forticel for molding bodies and caps to precise, stable dimensions. An example is the Scripto ball point pen.

# ACETATE molding compounds

Acetate is a very widely used cellulosic plastic. Economical and versatile, its usefulness extends over a wide range of consumer products.

In toughness, acetate can seldom be matched by any other plastic in its price bracket. It has high impact strength, rigidity, a hard surface, satisfactory dimensional stability for many applications. Acetate is free of objectionable odor, has practically no taste, and has relatively good temperature stability, which permits its use in refrigerators. The XK series is formulated entirely of ingredients considered acceptable for use in contact with foods by the Food & Drug Administration. Dielectric properties are good. The plastic is unharmed by common hydrocarbons such as gasoline, benzene and oils.

Acetate has excellent moldability, and molding temperatures are not critical. The plastic is free-flowing, which minimizes the problem of weld lines, and is recommended for applications incorporating metal inserts. Acetate molds with an excellent surface finish. With the aid of pre-plasticizing machines, heavy parts can be molded in one cavity and family molds can also be used. Acetate is easily fabricated. Parts may be cemented together to give a bond as strong as the original pieces. Formulations can be widely varied in properties by use of various types and amounts of plasticizers.

Acetate is produced in a number of formulations—including flame resistant material in a broad range of flows. It is offered in a practically limitless range of transparent, translucent and opaque colors as well as crystal clear. Applications include: toys, shoe heels, appliance housings, toilet seats, jewelry, tool handles, sun glasses, brush backs.

## ELECTRICAL PROPERTIES

| | ASTM Method | Units | Typical Formula XM-H3 | Typical Formula XFA-H3 |
|---|---|---|---|---|
| **DIELECTRIC STRENGTH** | D-149-55T | | | |
| 0% R.H., 25°C. | | volts/mil | 390 | 370 |
| 50% R.H., 25°C. | | volts/mil | 350 | 360 |
| 95% R.H., 25°C. | | volts/mil | 320 | 340 |
| **VOLUME RESISTIVITY** | D-257-54T | | | |
| 0% R.H., 25°C. | | ohm-cm. | $10^{14}$ | $10^{14}$ |
| 50% R.H., 25°C. | | ohm-cm. | $10^{13}$ | $10^{13}$ |
| 95% R.H., 25°C. | | ohm-cm. | $10^{11}$ | $10^{11}$ |
| **DIELECTRIC CONSTANT** | D-150-54T | | | |
| 1 kilocycle, at | | | | |
| 0% R.H., 25°C. | | | 4.4 | 4.4 |
| 50% R.H., 25°C. | | | 5.2 | 5.1 |
| 95% R.H., 25°C. | | | 7.5 | 7.9 |
| 1 megacycle, at | | | | |
| 0% R.H., 25°C. | | | 3.8 | 3.8 |
| 50% R.H., 25°C. | | | 4.5 | 4.3 |
| 95% R.H., 25°C. | | | 6.5 | 6.5 |
| **POWER FACTOR** | D-150-54T | | | |
| 1 kilocycle, at | | | | |
| 0% R.H., 25°C. | | | .020 | .024 |
| 50% R.H., 25°C. | | | .024 | .024 |
| 95% R.H., 25°C. | | | .042 | .032 |
| 1 megacycle, at | | | | |
| 0% R.H., 25°C. | | | .038 | .041 |
| 50% R.H., 25°C. | | | .048 | .055 |
| 95% R.H., 25°C. | | | .050 | .055 |
| **Arc RESISTANCE** | D-495-48T | | | |
| 50% R.H., 25°C. | | | 175 | 61 |

## ACETATE FORMULA SERIES

| Property | Units | ASTM Method | XM SERIES Range S3 — H7 | | XL SERIES Range S5 — H4 | | XR SERIES Range S2 — H2 | | XP SERIES Range S — H2 | | XK SERIES Range MS — H4 | | XFB SERIES Range S — H4 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow Temperature | °C | D-569-48 | 125 | 185 | 115 | 170 | 130 | 160 | 135 | 160 | 140 | 170 | 135 | 170 |
| | °F | | 257 | 365 | 239 | 338 | 266 | 320 | 275 | 320 | 284 | 338 | 275 | 338 |
| Specific Gravity | | D-792-50 | 1.27 | 1.30 | 1.28 | 1.31 | 1.27 | 1.30 | 1.28 | 1.28 | 1.26 | 1.28 | 1.25 | 1.28 |
| Rockwell Hardness | R Scale | D-785-51 | 40 | 119 | 57 | 120 | 55 | 96 | 50 | 87 | 59 | 108 | 66 | 112 |
| Impact Strength (Izod) | ft. lb./in. notch | D-256-56 | 5.6 | 1.2 | 5.8 | 1.9 | 5.0 | 2.8 | 5.0 | 3.2 | 4.1 | 2.9 | 4.2 | 2.4 |
| Heat Distortion Temp. | °C. | D-648-56 | 46 | 74 | 44 | 73 | 50 | 65 | 48 | 61 | 52 | 61 | 50 | 58 |
| | °F | | 115 | 165 | 111 | 163 | 122 | 149 | 118 | 142 | 126 | 142 | 122 | 136 |
| Deformation Under Load | % change in height | | | | | | | | | | | | | |
| | —24 hours | D-621-51 | 37.0 | 3.0 | 32.2 | 4.0 | 30 | 13 | 33 | 15 | 6.7 | 0.2 | 3.8 | 1.2 |
| Tensile Strength | psi | D-638-56T | 2800 | 6400 | 3600 | 7400 | 3900 | 5800 | 2800 | 4800 | 2800 | 6100 | 2700 | 5800 |
| Elongation | % | D-638-56T | 52 | 16 | 47 | 16 | 45 | 30 | 50 | 30 | 45 | 33 | — | — |
| Flexural Strength | psi | D-790-49T | 2300 | 11200 | 4700 | 11600 | 4800 | 8900 | 2500 | 7100 | 5000 | 10000 | 6200 | 11100 |
| Compressive Strength | psi | D-695-54 | 12000 | 29000 | 13800 | 32500 | 16200 | 25700 | 14000 | 22500 | — | — | 14500 | 27100 |
| Water Absorption | % wt. gain + | | | | | | | | | | | | | |
| | soluble matter lost | D-570-54T | 2.7 | 2.7 | 2.1 | 2.6 | 2.4 | 2.6 | 2.4 | 2.4 | 2.3 | 2.4 | 4.5 | 2.8 |
| Weight Loss on Heating | % at 82°C. for 72 hours | D-706-55T | 10.8 | 0.5 | 8.1 | 0.7 | 8.1 | 3.5 | 6.0 | 4.0 | 6.0 | 1.2 | 3.1 | 0.8 |

**SHOE HEELS** molded of Celanese Acetate are tough. They take prolonged pavement pounding, resist breakage, can be nailed without splitting.

**TOYS**, like this famous doll, can be economically molded of acetate . . . are strong, attractive, colorful, light in weight—a pleasure for children to handle.

**TOILET SEATS** molded of Celanese Acetate are both sturdy and sanitary. They can be molded in colors to match bathroom decor, are easy to keep clean.

# POLYESTER RESINS

Celanese polyester resins are thermosetting liquids which are cured in the presence of peroxide catalysts to stable, infusible solids. Cure can be achieved at low temperatures and pressures down to atmospheric pressure. Tack-free cures can be made at ordinary room temperatures through the use of suitable accelerators.

Celanese polyesters are supplied in viscosities ranging from close to that of water to that of heavy molasses. Generally they are clear liquids, except for the thixotropic formulations. They are 100% reactive and are not dependent on the release of solvent or any volatile reaction product for solidification. When reinforced with fibrous glass cloth, laminates can be produced which often have a better strength-to-weight ratio than steel. The cured resins exhibit excellent resistance to moisture, heat, weathering and most chemicals. Electrical properties are outstanding.

These resins are available in a number of formulations which can be blended to obtain specific properties in the finished product. A full range of thixotropic resins is available for use in hand lay-up on vertical or sloping surfaces where resistance to resin drainage is required. Special sprayable thixotropic resins for use in spray layup equipment, such as the Rand gun or the Hupp gun, are available. A broad line of fast-cycle press molding resins using either styrene, vinyl toluene, or diallyl phthalate monomer is available to cover virtually any requirement for premix, preform, or mat molding. Celanese polyester resins make possible the molding of large and intricate parts by modern fast cycle methods. Applications include: boats, car and truck bodies, corrugated and flat sheeting, machine housings, auto body fillers, tanks and tank linings, swimming pools, ornamental laminates and castings, coatings, electronic parts, and automotive and appliance components.

**PHYSICAL AND CHEMICAL PROPERTIES**

**Laminates Reinforced with 12 plies #181-136 Glass Cloth, According to MIL-R-7575 (USAF) Specifications**

| Properties at Standard Conditions | Gen. Purpose MR-28C | Gen. Purpose MR-28R | Pre-mix MR-40R | Match die MR-42R |
|---|---|---|---|---|
| Flexural, Flatwise, Ultimate Strength, psi | 61,300 | 67,400 | 52,000 | 75,000 |
| Flexural Tangent Proportional Limit, psi | 51,600 | 32,500 | | |
| Flexural Initial Modulus of Elasticity, psi | $2.83 \times 10^6$ | $2.72 \times 10^6$ | $2.8 \times 10^6$ | $3.2 \times 10^6$ |
| Ultimate Tensile Strength, psi | 47,000 | 47,100 | 37,000 | 50,000 |
| Ultimate Compressive Strength Edgewise, psi | 37,300 | 37,900 | | |
| Water Absorption, 24 hours, percent weight change | +0.1 | +0.05 | +0.6 | +0.2 |
| Rockwell M. Hardness | 103 | 114.2 | 110 | |
| Barcol Hardness | 67.5 | 67.0 | 63 | 70 |
| Barcol Hardness of Unfilled Casting (25° C) | 50-55 | 50-53 | 47 | 50 |
| Specific Gravity | 1.88 | 1.84 | 1.08 | 1.15 |
| Resin Content Percent | 35.3 | 37.0 | 70 | 70 |
| Viscosity (25° C), Brookfield Viscometer, cp | 650 | 7,000-10,000 | 2,000-2,500 | 2,000-2,500 |

# POLYVINYL ACETATE EMULSIONS

Celanese PVAc resin emulsions are milk-white liquids containing 50-55% polymer solids with viscosities ranging from water-thin to extremely viscous. Use of these emulsions eliminates the need for expensive, flammable, odorous, or toxic solvents, since they are water-based. These emulsions offer the advantage of high solids content with good fluidity and have excellent freeze-thaw, mechanical and storage stability. Celanese PVAc emulsions are presently being used in water-based paints, textile finishes, paper coatings, and adhesives. The latest material is a new vinyl-acrylic emulsion CL-203.

**PAINTS.** Vinyl paints made with Celanese CL-102 homopolymer and CL-202 copolymer PVAc emulsions offer quick drying, low cost, excellent alkali resistance, and good weathering properties. The paints have practically no odor, spread easily, and provide excellent coverage with uniform color and sheen. Celanese PVAc emulsions have set new standards for film clarity and resistance to water spotting. The films also resist sunlight, oils, solvents, greases. The fine particle size of the paint emulsions insures superior pigment binding, eliminates problems of settling in the can, produces tighter, tougher, more closely-knit films.

*Applications:* Interior flat paints, exterior masonry paints, primers, semi-gloss paints, and industrial metal finishes. Celanese has developed high-gloss formulations and exterior formulations that adhere excellently to chalky surfaces.

**TEXTILE FINISHES.** Celanese PVAc finishes improve stiffness, durability, strength and wrinkle recovery of woven fabrics. The emulsions can be used in many textile sizing formulations. They are particularly suited for cotton and acetate fabrics, from lightest to heaviest weaves.

**PAPER COATINGS.** Scuff-proof paper coatings can often improve surface durability by a factor of five. In addition to scuff-proofness, Celanese PVAc finishes upgrade lower-quality papers and form a good base for color coats. They eliminate fire hazards of flammable solvents.

**ADHESIVES.** PVAc emulsions can be used to make outstanding adhesives for bonding porous materials such as paper and cardboard. The films provide high bond strength, and since the emulsions are water-based, machinery can easily be cleaned. PVAc adhesives are also used for transparent plastic packaging films, acoustic insulation, wood, tile. They are excellent for packaging.

**TYPICAL PROPERTIES OF CELANESE POLYVINYL ACETATE EMULSIONS AND FILMS**

| Properties of Emulsions | CL-100 | CL-101 | CL-102 | CL-202 | CL-203 |
|---|---|---|---|---|---|
| Solids content, % | 55 ± 1 | 55 (Min.) | 55 ± 1 | 55 ± 1 | 55 ± 1 |
| pH | 4-5 | 4-5 | 4-5 | 4-5 | 4-5 |
| Viscosity, cp. | 1000-1500 | 800-1200 | 1000-1500 | 1900-2500 | 1900-2500 |
| Particle size | medium | large | small | small | medium |
| Free monomer, maximum % | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Weight per gallon, lb. | 9.2 | 9.2 | 9.2 | 9.1 | 9.1 |
| Odor | very slight | very slight | very slight | very slight | slight |
| Borax stability | poor | poor | excellent | excellent | excellent |
| Settling after dilution | | | | | |
| After 4 days, ml. | 4 | 5 | 2 | 1 | 1 |
| After 13 days, ml. | 8 | 8 | 3 | 1 | 1 |
| **Properties of Films** | | | | | |
| Clarity and gloss | good, moderate | fair severe | excellent slight | excellent slight | excellent slight |
| Water spotting | | | | | |

# CELLULOSE ACETATE FILM

Celanese Acetate film is an economical thermoplastic material widely used for its sparkling clarity and ease of processing. Acetate is readily slit, cut, laminated, metallized and printed. High speed and automatic operations may be employed. The plastic can be sealed rapidly with heat and solvents, has a long shelf life, and does not block under most conditions of storage. Available in thicknesses from 0.0005" to 0.002", these materials are offered in a broad range of widths, continuous lengths, and cut sheets in clear transparent.

Celanese Acetate film is manufactured in two types: cast and extruded. These are generally similar in appearance and properties, and can be used interchangeably in many applications. The cast type is a premium quality film outstanding for its perfection of surface, grainless transparency and uniformity. Both film types are produced in a number of formulations to fit specific applications. The excellent physical and mechanical properties of Celanese Acetate films provide many important advantages, such as:

**Excellent transparency.** Celanese Acetate is crystal-clear and grainless. In packaging it gives product visibility at all times.

**Long shelf life.** Celanese Acetate retains its original strength over long periods of time, because there is no highly volatile substance to evaporate and make the material brittle. It does not block in storage.

**Dimensional stability.** Celanese Acetate resists dimensional change even under widely varying atmospheric conditions. This means that overwrapping produces a neat, trim package.

**Mold retardance.** Celanese Acetate is extremely resistant to the growth of mold, germs, fungi, and other infestations.

**Resistance to fogging.** Celanese Acetate resists fogging in humid, cold cabinets and will gradually dissipate fog upon rapid changes in temperature and humidity.

**High permeability to gases.** Celanese Acetate is the most desirable film where good transparency and gas or vapor transmission are required to eliminate high gaseous concentrations. To achieve this effect with most other films, perforation is necessary.

**Excellent greaseproofness.** Celanese Acetate is highly resistant to most greases.

**Printability.** Celanese Acetate provides an excellent surface for clear, sharp printed impressions. When printed in reverse it gives added depth, lustre and brilliance to printed impressions.

**Ease of fabrication.** Celanese Acetate is readily slit, cut, laminated, metallized and printed by simple or high speed automatic operations. It heat seals and solvent seals rapidly.

Applications for Celanese Acetate film include: metallizing, electrical insulation of many types, backing for magnetic recording tape, pressure-sensitive tape, gold stamping foil and decorative ribbons. It is also used in pouches, envelopes and protective covers of all types; multiple layer, three-dimensional illustrations of industrial equipment; over-wraps for packaging of long shelf-life merchandise, as well as fresh produce and bakery products.

**TYPICAL PROPERTIES OF ACETATE FILMS***

| Formula | P 903 | P 904 | P 907 | P 911 | P 912 | S 600 | S 650 | S 602 | S 652 |
|---|---|---|---|---|---|---|---|---|---|
| Thickness Range, inches | 0.00088<br>0.002 | 0.00088<br>0.002 | 0.0007<br>0.002 | 0.00088<br>0.002 | 0.0007<br>0.002 | 0.0005<br>0.002 | 0.0005<br>0.002 | 0.0005<br>0.002 | 0.0005<br>0.002 |
| Specific Gravity | 1.26 | 1.31 | 1.32 | 1.31 | 1.30 | 1.31 | | 1.29 | |
| Tensile Strength, psi | 7000-9000 | 9000-12000 | 12000-13000 | 7800-8500 | 8000-12000 | 7000-10000 | 7000-10000 | 7000-9000 | 7000-9000 |
| Elongation, % | 25 - 35 | 15 - 25 | 31 - 42 | 15 - 25 | 20 - 30 | 25 - 50 | 25 - 50 | 30 - 55 | 30 - 55 |
| Softening Temperatures** | | | | | | | | | |
| °C. | 125 | 175 | 150 | 125 | 150 | 150 | 150 | 140 | 140 |
| °F. | 260 | 350 | 300 | 260 | 300 | 300 | 300 | 285 | 285 |
| Heat Shrinkage, % | | | | | | | | | |
| 48 hr., 60°C. (140°F.) | 1.5-2.5 | 0.05 0.2 | 0.1-0.3 | 1.0-2.0 | 1.0-2.0 | 0.1-1.0 | 0.1-1.0 | 0.2-1.5 | 0.2-1.5 |
| 48 hr., 116°C. (240°F.) | 4.0-6.0 | 0.9-1.5 | 1.9-2.6 | 5.0-7.0 | 3.5-4.5 | 2.0-4.0 | 2.0-4.0 | 3.0-5.0 | 3.0-5.0 |
| Moisture Absorption, % | | | | | | | | | |
| 24 hr., 0% RH. plus 48 hr., 90% RH. | 4.0 | 8.5 | 5.4 | 3.5 | 4.5 | 4.5 | 4.5 | 3.5 | 3.5 |

*All tests were made after the samples had been conditioned for 24 hours at 50% relative humidity and 25°C. (77°F.), and the tests were made under the same conditions.

**Softening Temperature—Temperature at which sample becomes limp when heated on a polished copper block at rate of 15°C. per minute. Samples conditioned before testing for at least 24 hours at 50% RH. and 23°C.

**FACE SHIELD of Celanese Acetate sheeting demonstrates the clarity and sparkle of the material—and its use as a strong, protective window.**

**SEE-AND-SELL PACKAGES come in hundreds of shapes, sizes and forms. All sorts of products enjoy a personal showcase on the buying world through Celanese Acetate.**

**ACETATE BASE RECORDING TAPES eliminate background noise, permit faithful reproduction. They resist stretching even under strong rewind tension.**

# CELLULOSE ACETATE SHEETING

Celanese Acetate sheeting is a thermoplastic material produced by solvent casting and dry extrusion. The excellent physical and mechanical properties of this sheeting provide many important advantages for a wide range of application These include:

**Ease of fabrication.** Celanse sheeting can be easily die cut, beaded, punched, stitched, embossed, laminated and cemented.

**Excellent thermoforming.** Celanese sheeting can be formed by all conventional thermoforming methods. The most popular is vacuum forming.

**Toughness.** Celanese sheeting has good impact resistance over a range of temperatures. It does not craze or crack under normal stresses.

**Rigidity.** Celanese sheeting does not become limp or distort under normal high temperature.

**Good aging properties.** Celanese sheeting does not discolor with age nor become brittle over long periods of time.

**Excellent printability.** Celanese sheeting can be printed by gravure, letterpress, flexography or silk screen. The excellent surface provides clean, sharp impressions. The sparkling clarity of clear, transparent sheeting provides a lustrous surface to complement quality printing.

**Grease resistance.** Celanese acetate is excellent for the containment of greases and oils. Approved under MIL-T-21484 for blister packages for bearings.

**Colorability.** In addition to the clear transparent product, Celanese sheeting is available in a wide range of colors, both transparent and opaque.

**CAST SHEETING.** Cast sheeting is produced in several formulations in continuous length rolls, gauges 0.003" through 0.020". It is manufactured in clear transparent only, but can be surface tinted with transparent colors. Cast sheeting has a grainless surface of high perfection and is recommended for applications requiring the best optical clarity and greatest rigidity. For special applications cast sheeting can be supplied with a continuous matte surface. Although produced in continuous lengths, cast sheeting can also be supplied in stock size or cut-to-size sheets.

**EXTRUDED SHEETING.** Extruded sheeting is produced in a wide range of formulations. It is available in continuous length rolls, gauges 0.003" through 0.030". It is also produce din sheets 0.003" through 0.250". The wide range of formulations assures proper selection of a suitable material for a specific application. Certain formulations are compounded entirely of ingredients acceptable to the Food and Drug Administration in connection with food packaging.

Extruded sheeting is manufactured in clear transparent and in an unlimited range of transparent to opaque colors. This sheeting is economically priced and can also be supplied in a variety of finishes. The most common finishes are "as extruded," high polish, and matte.

Applications for Celanese Acetate sheeting include: Transparent containers and proective covers. Contour, blister and skin-type packages. Personal accessories such as costume jewelry, buttons, handbags. Optical frames, face shields, safety goggles, and safety devices. Transparent sheets for printing. Loose-leaf insert folders. Toys and games.

**PROPERTIES OF ACETATE SHEETING**

| Property | Test Method | Units | CAST SHEET .003" Gauge L-822 | CAST SHEET .003" Gauge L-864 | CAST SHEET .010" Gauge L-822 | CAST SHEET .010" Gauge L-864 | EXTRUDED SHEET 0.010" Gauge S-700 | S-704 | S-712 | S-729 | S-732 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tensile Strength | D882-56-T Method B | psi | 12,000 | 11,500 | 11,000 | 10,500 | 7200 | 7500 | 7500 | 7900 | 8000 |
| Elongation | Method B | % | 38. | 40. | 41. | 45. | 68 | 70 | 73 | 67 | 71 |
| Mullen Burst Strength | — | psi | 100 | 100 | 300 | 300 | 210 | 210 | 200 | 230 | 230 |
| MIT Fold Endurance | D643-43 Method B | No. of double folds | 100 | 100 | 10 | 10 | 16 | 20 | 16 | 12 | 16 |
| Elmendorf Tear Strength | — | gms | 20 | 25 | 100 | 100 | 150 | 160 | 180 | 170 | 160 |
| Edge Tear Resistance | D1004-49-T | lbs/in. | | | | | 1450 | 1250 | 1200 | 1150 | 1450 |
| Flammability Rate | D568-56T | Rating | non-burn. | non-burn. | non-burn. | self-ext. (smothers) | Burning | Self-ext. (drips off) | Burning | Self-ext. (drips off) | Burning |
| Flammability Rate (SPI) | D1433-58 | sq. in./min. in/sec. | — .55 | — .75 | — .25 | 1 .30 | 40 0.55 | 0 0.35 | 35 0.45 | 0 0.35 | 45 0.60 |
| Tensile Heat Distortion Temperature | at 2% Extension at 50% Extension | °C °C | 140 175 | 135 170 | 130 165 | 125 160 | 105 140 | 105 125 | 110 145 | 110 140 | 110 150 |
| Heat Shrinkage | 48 hr. at 120°F. 48 hr. at 240°F. | % % | 0.17 1.3 | 0.24 2.2 | 0.21 0.8 | 0.25 1.7 | 0.45 4.1 | 0.10 5.2 | 0.30 3.9 | 0.15 3.3 | 0.35 4.4 |
| Total Light Transmission | D672-45T | % | 92 | 92 | 91 | 91 | 91 | 91 | 91 | 91 | 91 |
| Haze (Kline-Bowen) | D672-45T | % | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Refractive Index | D542-42 | (air = 1) | — | — | — | — | 1.496 | 1.498 | 1.490 | 1.492 | 1.490 |
| Specific Gravity | D792-44T at 23°/23°C | — | 1.31 | 1.31 | 1.31 | 1.31 | 1.29 | 1.32 | 1.29 | 1.30 | 1.29 |
| Water Vapor Transmission | F96-53T 0-50% RH, 73°F 50-100% RH, 73°F 0-90% RH, 100°F | g/24 hr/sq.m. | — 45 200 550 | — 40 175 500 | — 15 75 190 | — 13 65 170 | — 30 70 190 | — 25 65 170 | — 30 75 190 | — 25 65 160 | — 30 75 200 |
| Moisture Absorption | 48 hr, 50% RH, 73°F 48 hr, 90% RH, 73°F | % % | 2.0 6.0 | 1.5 5.5 | 2.0 5.5 | 1.5 5.0 | 1.5 4.5 | 1.5 4.5 | 1.5 4.5 | 1.5 4.5 | 1.5 4.5 |
| Water Absorption | D570-54T | % | 7.5 | 6.5 | 7.5 | 6.5 | 6.0 | 6.5 | 6.5 | 6.0 | 6.5 |

• To the best of our knowledge the information contained herein is accurate. However, neither Celanese Corporation of America nor any of its affiliates assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of the suitability of any information or material for the use contemplated, the manner of use and whether there is any infringement of patents is the sole responsibility of the user.

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We offer technical service for all our plastics. Our experience ranges from the earliest plastics discoveries. A continuous research program is aimed at perfecting formulations and expanding our plastics capabilities. If you have a problem, we may be able to tailor a formulation to satisfy your special needs. Celanese warehouses and facilities at strategic points assure fast deliveries wherever you are located.

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PLASTICS
THE MAGAZINE OF APPLIED ENGINEERING
TECHNOLOGY

SEPTEMBER, 1959

# EDITORIAL: Extrusion and Blow-Molding Machines & Auxiliaries

In this issue, we are proud and quite pleased to present a special section on 1959 Extrusion and Blow-Molding Machines and Auxiliary Equipment.

Following the system used in the past for our special machinery compendia, the section begins with a lengthy and thought-provoking article on "What a Plastics Engineer Should Look For When Planning to Buy Auxiliary Equipment for Extrusion," written by Bob Monica, Head of the Extrusion Section for Dow Chemical Company's Plastics Technical Service.

In his capacity with Dow, Monica can speak authoritatively on what plastics processors should consider when planning to purchase plastics extruders, and calls attention to many problems that must be considered. In many ways, the article can be deemed as a continuation of Monica's article in our September 1958 issue on "What a Plastics Engineer Should Look For When Planning to Buy an Extrusion Machine."

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Following the introductory article in this issue's special section are a lengthy and comprehensive tabulation of PT's Comparative Data on 1959 Extrusion Machines; a tabulation of PT's Comparative Data on 1959 Blow Molding Machines; and PT's Classified List of Auxiliary Equipment for Extrusion.

The need for our coverage of 1959 extruders arose from the many new machine models developed since our 1958 tabulation last September. That tabulation received universal acclaim from our readers, the plastics processing engineers, who applauded our efforts to assist them, other users of extruders, and even the machine manufacturers by demonstrating the then-existing state of non-standardization for extrusion machines.

In this respect, it should be noted that there was much less difficulty in obtaining the desired tabulation data from the suppliers this year for the 1959 models shown in our comparative data listing this month. Obviously, standardization in extruder specifications is no longer just a dream for the future.

The classification system used in the current data tabulation is quite similar to last year's, with perhaps the major improvement being the use of B-10 service lift to indicate the life expectancy of the thrust carrier in each extruder model.

The tabulations on 1959 blow-molding machines and the classified list of auxiliaries are new for our publication. Blow-molding units have now come into their own, and are the subjects of widespread interest. While some of the original blow-molding units could be considered as extrusion auxiliaries, current units work off extruders, injection molding units, and vacuum forming machines. As such, blow-molding machines merit separate consideration, and our tabulation will point out the paths for future work on standardization.

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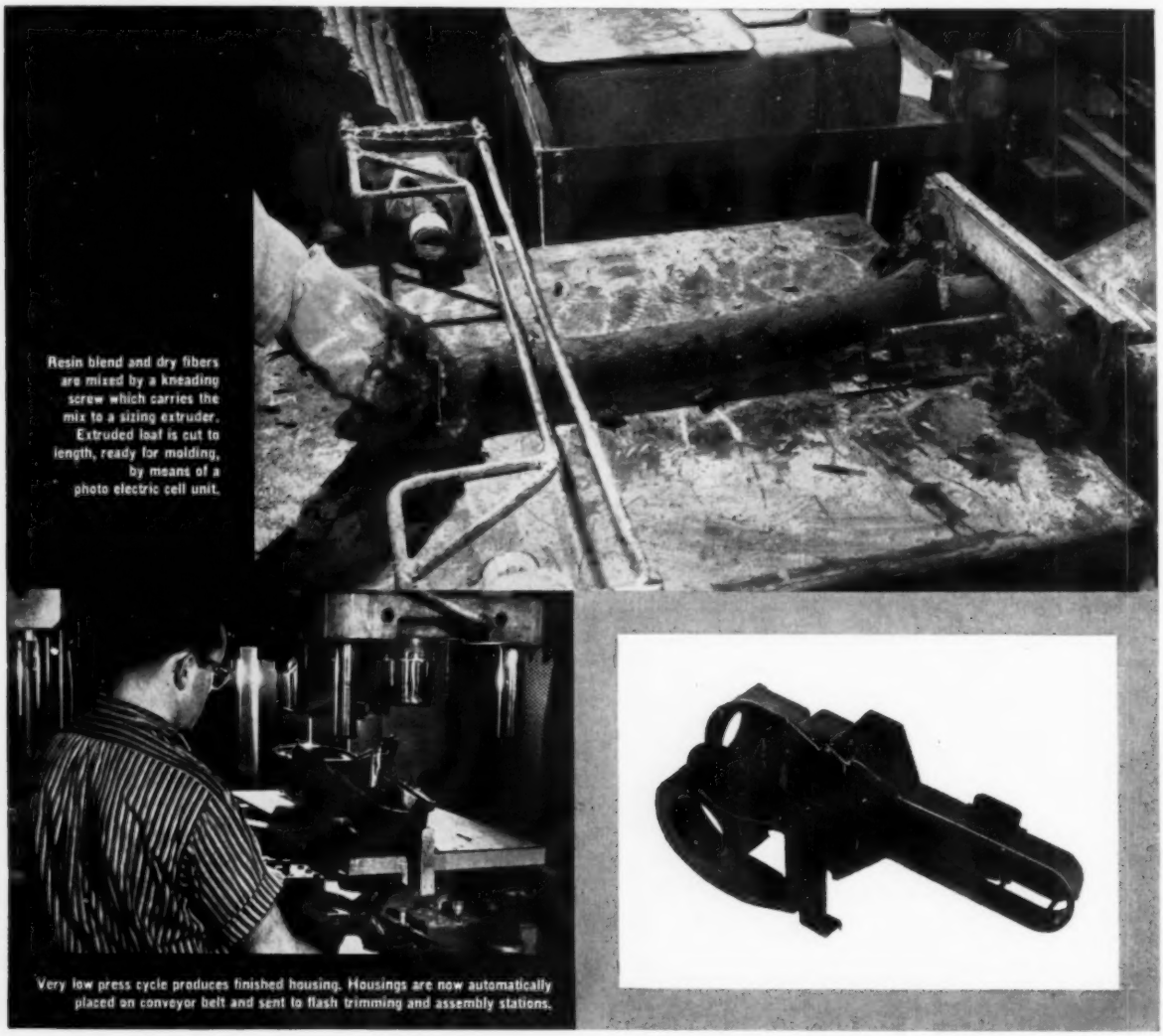
So there you have it, our 1959 special section. We hope that it will be valuable to both the processors and the suppliers, and invite your comments.

Arthur M. Merrill
Editor

DOW | VINYLTOLUENE



Resin blend and dry fibers are mixed by a kneading screw which carries the mix to a sizing extruder. Extruded loaf is cut to length, ready for molding, by means of a photo electric cell unit.

Very low press cycle produces finished housing. Housings are now automatically placed on conveyor belt and sent to flash trimming and assembly stations.

# Premix moldings speed assembly, make a better heater housing for Ford Motor Company

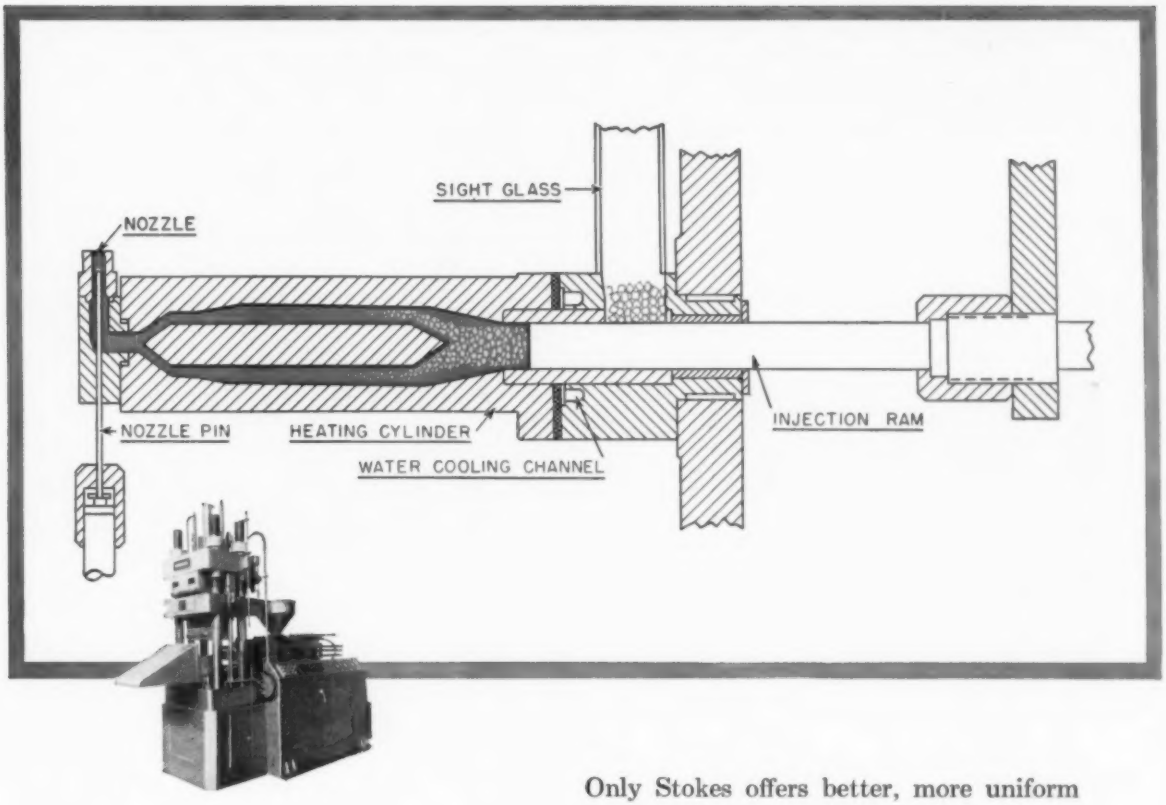
When you turn to premix moldings for reinforced plastic parts, you benefit from higher quality of product and increased production. The Ford heater housing above is a prime example.

The housings formerly were made of stamped and welded metal. A switch to premix molding eliminated time-consuming assembly problems, produced a better product and increased production rate. Fillets, slots, holes and recesses are formed in the mold, clean-cut and precisely located. Final assembly is quick and easy. Unit costs are lower.

For making reinforced plastic products, premix molding has many advantages. Because the reinforcing fibers are blended with the resin *before* molding, they are uniformly distributed, regardless of wall shape or thickness. This means uniform strength throughout the unit. Preforming is eliminated. So are resin-rich areas, no matter how complex the mold or how heavy the section.

Molders of strong, rigid, reinforced plastic parts have found that premix moldings made with Dow vinyltoluene and Dow styrene have definite manufacturing and product advantages. Production is higher, costs are lower. Premix molding may benefit *your* operation, too. For more information, write today to THE DOW CHEMICAL COMPANY, Midland, Michigan, Dept. 2378DT9

**THE DOW CHEMICAL COMPANY · MIDLAND, MICHIGAN**




# pressure pre-pack pays off!

Only Stokes offers better, more uniform parts and faster molding cycles with exclusive pressure pre-pack. Here's how it works: positive nozzle shutoff through action of the nozzle pin permits pressure pre-packing of the heating cylinder. All granular material is under pressure from the moment it enters the cylinder. Plasticizing capacity is increased, and injection time decreased as much as 75%.

Stokes pressure pre-pack is another feature that will help increase the quality of your product, and at the same time, reduce total operating costs. We'd like to give you all the facts on Stokes automatic injection molding . . . including *positive* ejection, *positive* nozzle shutoff, and *positive* pressure pre-pack. Why not get in touch with Stokes . . . today.

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**STOKES**

# Count on INVIN* 91 stabilizer to provide crystal clarity, lasting non-yellowing in vinyls

Count on 4 important stabilizing actions from INVIN 91 stabilizer, versatile liquid barium-cadmium stabilizer for clear, filled and colored vinyl stocks.

1. **Outstanding crystal clarity** — in calendered and extruded products.
2. **Unique inhibition of yellowing** — in processing, in service.
3. **Exceptional heat stability** — ample for modern high-heat, high-speed processing.
4. **Powerful light stabilizing action** — in severe outdoor and auto upholstery service.

### INVIN 91 stabilizer aids formulating, too

Count on INVIN 91 stabilizer for two formulating benefits:

(1) Compatibility with *all* of the commonly used plasticizers – the organic ester types, the more sensitive phosphates, organic epoxides, ether esters, polyesters and hydrocarbons. Special plasticizer combinations, too, pose no serious problems.

(2) Wide choice of lubricants in addition to stearic acid . . . without regard to effect on heat stability.

Count also on minimum plate-out . . . even under difficult conditions.

National Lead Research has developed outstanding stabilizers that meet specialized problems in *all* vinyl stocks made today . . . such as high temperature service in electrical insulations; oxidation in outdoor products; color-changing impurities and temperatures in flooring; heat and light stability in plastisols, organosols. Each National Lead Company stabilizer simplifies processing, extends useful product life.

**Ask us for suggested formulations and 4-page technical brochure on INVIN 91 stabilizer. Ask, too, for our comprehensive 12-page catalogue of vinyl stabilizers and gelling agents.**

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*A Chemical Development of* **National Lead Company**

**111 Broadway, New York 6, N. Y.**

*In Canada:* CANADIAN TITANIUM PIGMENTS LIMITED, 630 Dorchester Street, West • Montreal

# NEWS in BRIEF

What's New in Processing is the title of a new section starting in this issue. Here, all news and data on processing will be given special emphasis, including news items on new or improved techniques, processing patents, abstracts of both foreign and domestic articles on the subject, books on processing, and company literature dealing with process methods.

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Secrecy and a return to the closed-shop method is advocated by Ren Morse, of Injection Molders Supply, as the sure method of preserving design, process, or equipment developments (see Guest Editorial, pg. 65), particularly in view of the difficulties in obtaining adequate legal protection against pirated developments. (PT's views on secrecy in the plastics industry will be given in next month's Editorial.)

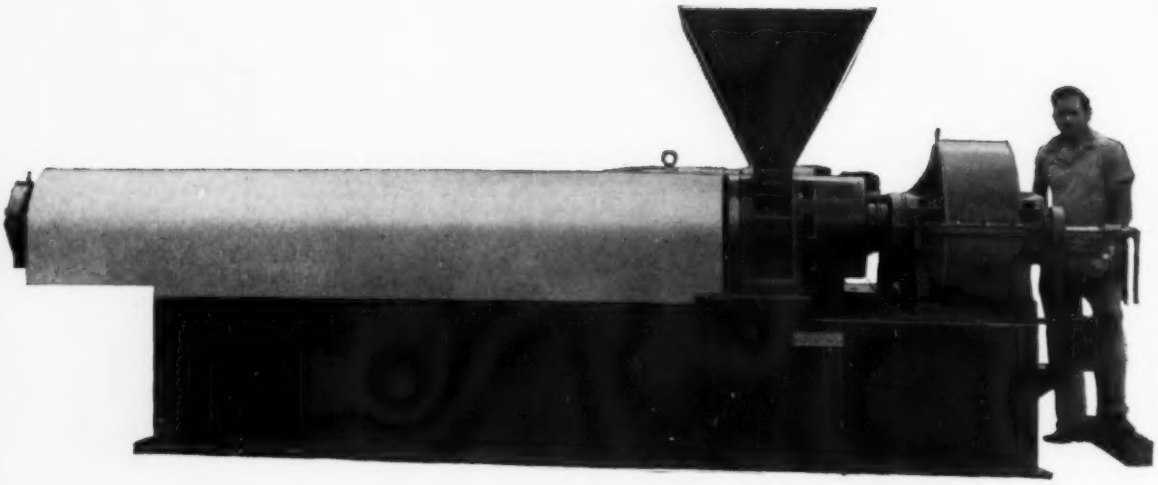
Business developments in plastics this month are of two types. Fluorocarbon Products became a production department of its parent firm, Garlock Packing Co. Celanese organized three new companies—Celanese Fibers, Celanese Chemical, and Celanese Plastics. Hooker signed a license agreement with General Electric. J. M. Huber licensed Pacific Coast Chemicals to distribute its kaolin clays and silicate pigments in Northern Calif. U. S. Rubber licensed Ford Motor Co. to use its Marvibond continuous laminating process for vinyl sheet to metal.

Company expansions in plastics are recovering from the summer let-down. Aeroplastic Corp. moved to new, larger quarters in Venice, Calif. Plans for a new vinyl chloride polymer plant were announced by American Chemical at Watson, Calif. American Cyanamid opened its new maleic anhydride plant at Bridgeville, Pa. A new plant was erected by Beetle Plastics in Fall River, Mass. Borden completed its expansion at its Compton (L.A.), Calif., plant. Plans to expand its production of acrylic rods and sheet were given by Cadillac Plastic & Chemical for its Warren, Mich., plant. Carlon Products has expanded its pipe-producing facilities at Aurora, Ohio. An expansion of its production and storage facilities at Elkton, Md., is underway at Colton Chemical. Dewey & Almy is completing construction of a new lab and pilot plant at Cambridge, Mass. DuPont plans to produce polyethylene at its Victoria, Tex., plant. Emery Industries plans an expansion of its plant in Cincinnati, O. J. P. Frank Chemical will increase its production of vinyls in Brooklyn, N. Y. A new research & development lab is being built by Formica in Evendale, O. Georgia Marble's Calcium Products division opened a new plant near Atlanta, Ga. Entry into the extrusion coatings field was announced by Protective Coatings Corp. Plans to erect a reprocessing plant at Orange, Tex., have been announced by A. Schulman.

New Materials to be noted (see pages 95-6): polyethylene pipe extrusion compound; two epoxy potting compounds; three rigid styrene copolymer materials; blowing agent for urethane foams; polyethylene molding material; polyester potting resin; and grease-resistant polyethylene coating for board and paper products.

New Equipment worthy of attention (see pages 97-8): infra-red preheater attachment for presses; pressure reducing valves; single-zone temperature control unit; light-scattering photometer; and spray gun for reinforced plastics.

Plastics Applications of special interest (see pages 99-105): coated cotton fabric; vacuum-free nursing bottles; molded phenolic handles for saucepans; h-d polyethylene food containers with sliding lids of transparent styrene; toy guns of black vinyl; one-piece molded melamine lavatory table and washbasin for jet planes; table-model vacuum forming unit; molded butyrate case for automobile ignition timing light; series of high impact pipe fittings; and fish lures of molded butyrate.

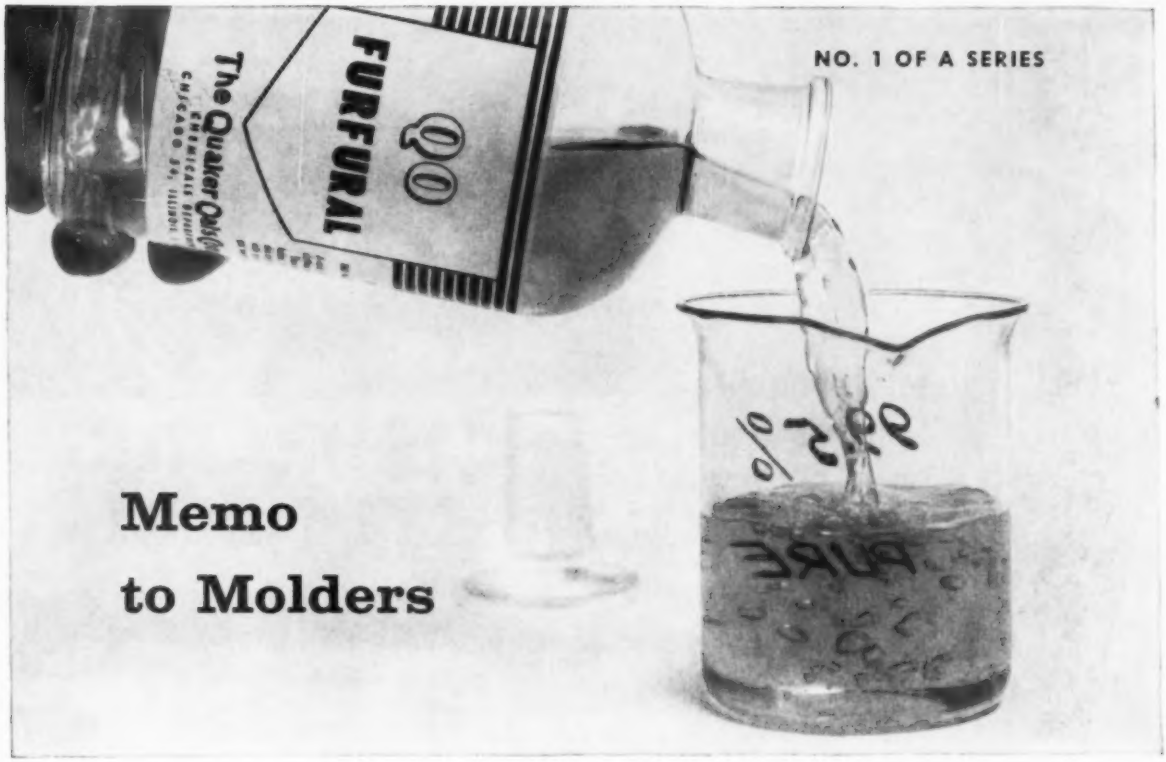


# STERLING

This 6″ Sterling extruder will out-produce any comparable machine... precisely because it was designed to do so, to meet the purchaser's requirements. Sterling will build an extruder to **your** special requirements, whether they fall within conventional ranges or exceed them. Sterling Extruders are available in sizes of 1½″, 2″, 2½″, 3½″, 4½″ and 6″ with L/D ratios of 15:1, 21:1, 24:1 or 30:1. Also available are completely packaged units and installations for the production of tubing, film, sheeting, rods and shapes, and for compounding, coloring and laminating from a complete range of thermoplastic materials. For complete details, write directly to, or call, Mr. L. D. Yokana, President, Sterling Extruder Corporation, 1112 Baltimore Avenue, Linden, New Jersey. WAbash 5-3908.

# PRODUCTION

**STERLING EXTRUDERS** — *"Designed by plastics men for plastics men"*

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Furfural is a highly purified synthetic chemical, with broad industrial applications. For example—nylon is made from furfural. Premium grade lubricating oil is refined with it. Furfural is a key factor in the manufacture of butadiene—principal component of GR-S rubber.

AND . . . furfural is the same pure chemical which contributes important improvements to phenolic molding.

**Molding Advantages of Furfural Phenolics**

- **Excellent long flow characteristics**
- **Fast total molding time**
- **Good finish**
- **Improved electrical properties**
- **Less sticking in the mold**

Your phenolic molding compound supplier gives you an extra value when he uses furfural. It's a mark of quality.

The Quaker Oats Company does not manufacture phenolic molding compounds. However, we shall be pleased to furnish suppliers' names.

The Quaker Oats Company
CHEMICALS DIVISION
334E The Merchandise Mart, Chicago 54, Illinois

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## with IMS HEATING CYLINDERS

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- **UNIFORM PERFORMANCE** regardless of press make or model. Cylinders engineered to fit your machine.
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- **PROVEN** in nearly 1000 installations on every make and model of injection machine.

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IMS offers 2½ to 3 weeks delivery on Quality Replacement Heating Cylinders, engineered to meet your requirements.

More Capacity? Less Capacity? Nylon Shut-off Type—Mixing Type? Vinyl? Write Today!

Cut your press downtime — cut your maintenance costs. Have your foreman send us the few simple measurements we need to build a Uniform Design Heater for your specific press. Do it NOW!




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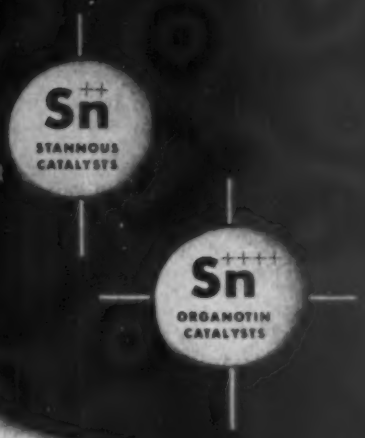


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## expressly for
# ONE-SHOT
# URETHANE FOAM

*Dibutyltin dilaurate*
*Dibutyltin di-2-ethylhexoate*
*Stannous octoate*
*Stannous oleate*

Only M&T supplies this full line of "one-shot" **CATALYSTS!**

One of the M&T catalysts listed above is essential to the success of almost every current one-shot urethane foam formulation. Having pioneered the development of these compounds, M&T keeps abreast of the rapidly advancing technology of their use and can offer practical technical service to those responsible for developing one-shot foam systems. For technical data sheets or other technical assistance, write or call.

M&T **Chemicals**
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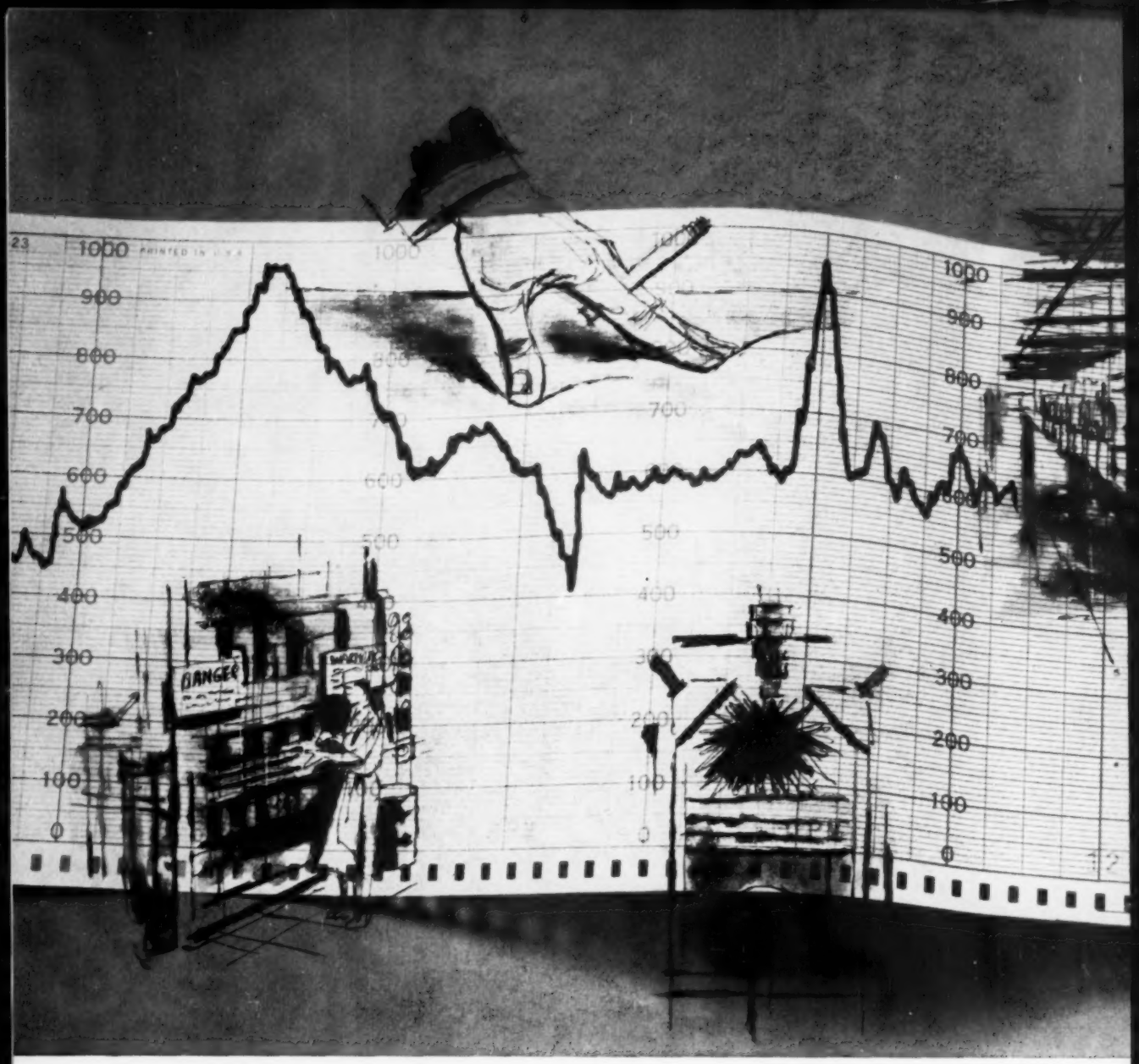
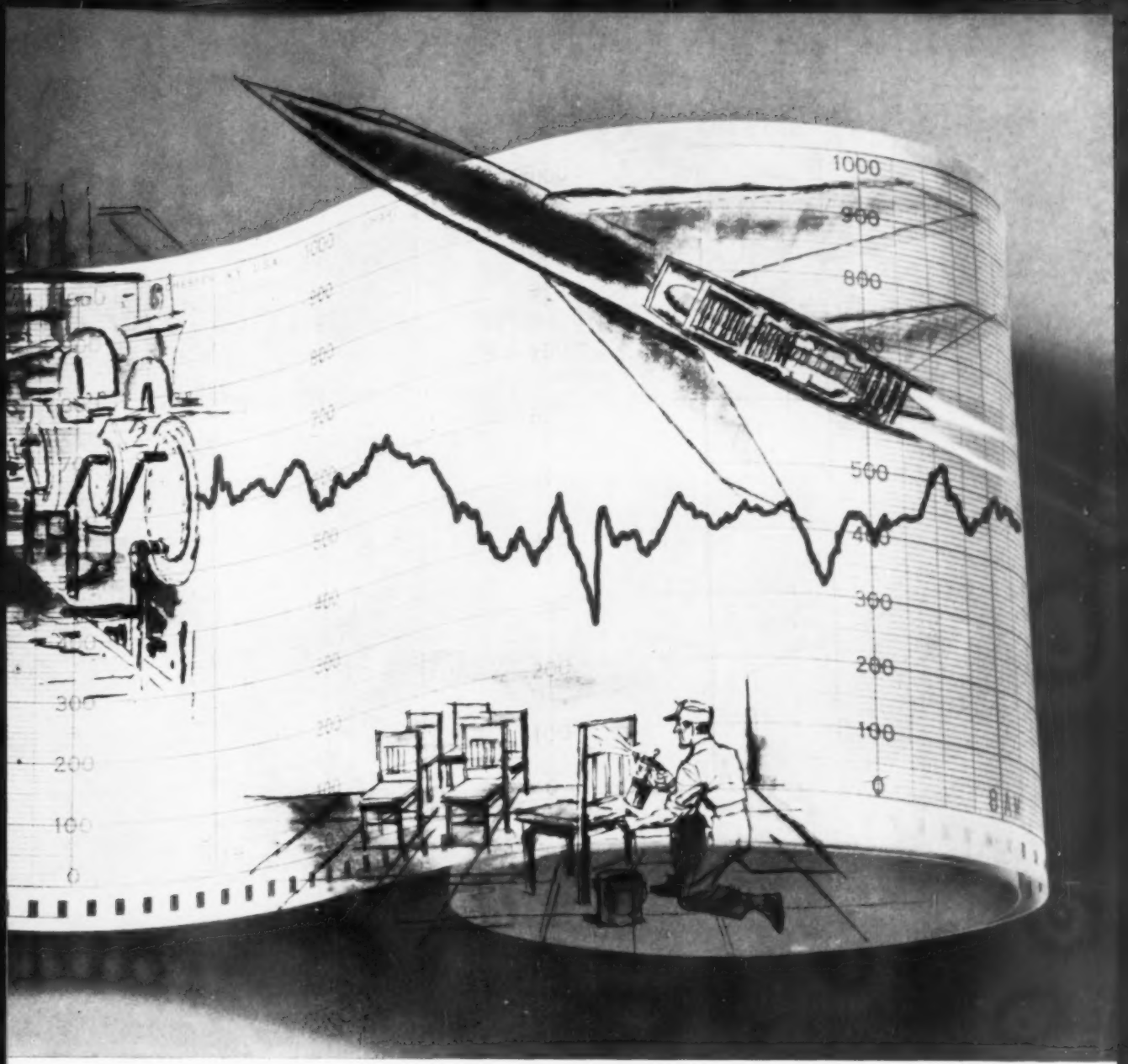



# To tame heat and

Does heat or flame present a hazard in your business or product, or set a limit to the efficiency of equipment? If so, Celanese has some chemical answers for you:

We have developed—and produce—fire-resistant synthetic lubricants and hydraulic fluids, fire resistant plasticizers, fire-retardant additives for paints and varnishes, motor fuel additives that improve combustion, and heat-resistant lubricants for high temperature applications. These products are typical examples of the contribution of Celanese to safety and progress in American industry. Take advantage of our long experience in reducing the hazards and losses of heat, fire and explosion. If you have such a problem, why not ask us to help? Write Celanese Corporation of America, Chemical Division, Dept. 564-S, 180 Madison Ave., New York 16.

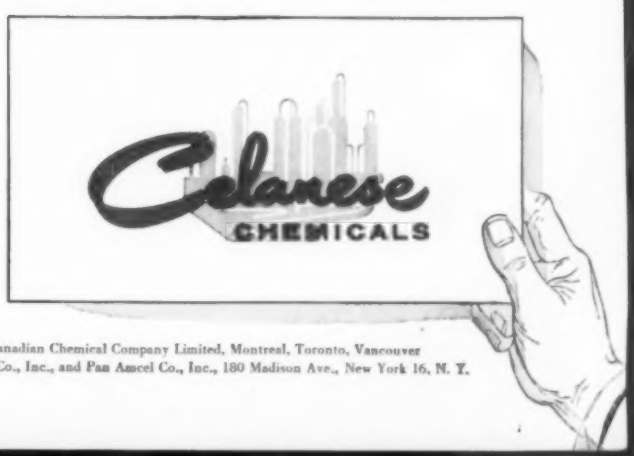
Celanese® Celluflex® Cellulube® Cellutherm™




# keep fire friendly

LEFT TO RIGHT

- Cellulubes, fire-resistant hydraulic fluids for safer operation of die casting machines, hydraulic presses and other power transfer units near potential sources of ignition.
- Celluflex plasticizers add fire resistance to urethane foams and other plastics.
- Fuel additives improve performance characteristics of gasolines.
- Cellulubes, combustion-resistant lubricants for air and gas compressors, also reduce maintenance costs.
- Celluflex plasticizers contribute the property of fire retardance to paints and varnishes.
- Cellutherm high temperature lubricants for faster jet engine speeds.

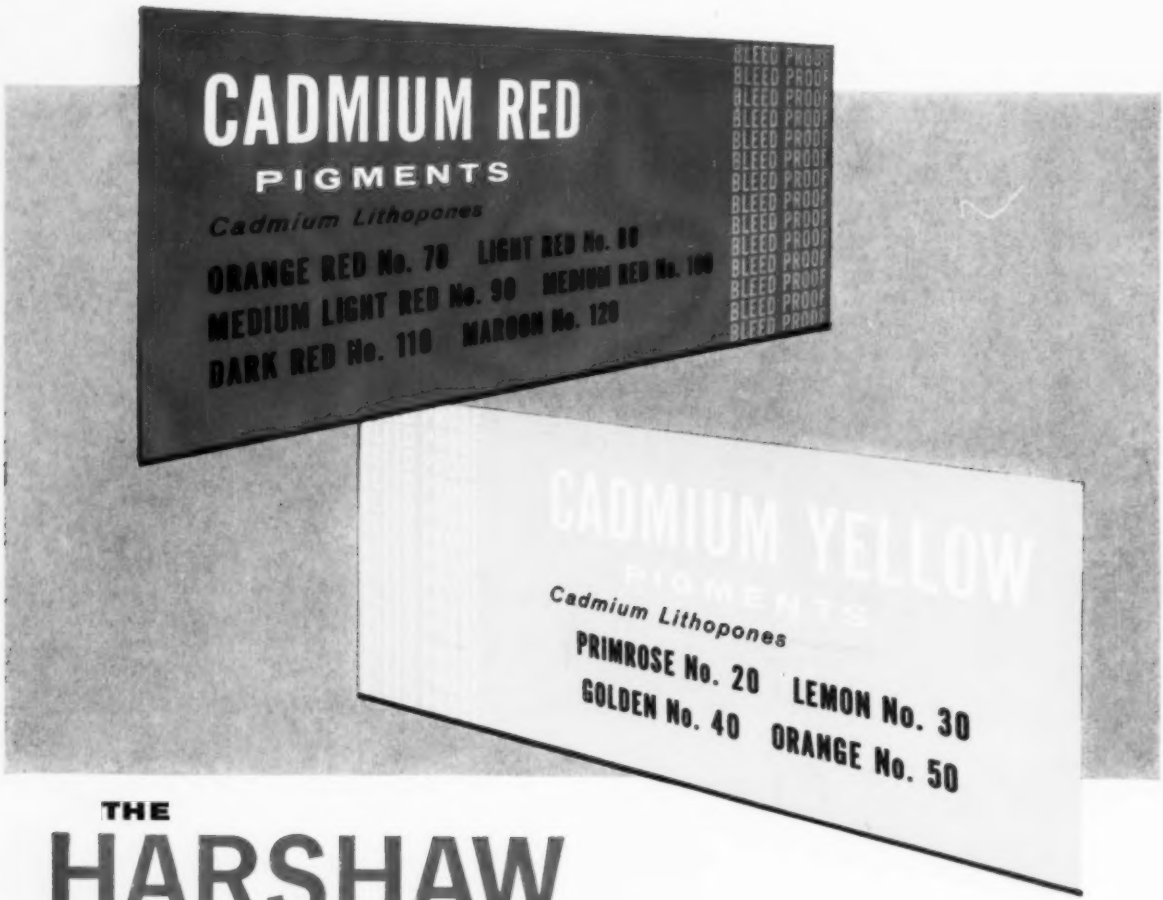



*Canadian Affiliate:* Canadian Chemical Company Limited, Montreal, Toronto, Vancouver
*Export Sales:* Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Ave., New York 16, N. Y.

# 10 BRIGHT COLORS

## for industrial finishes . . . plastics

*Exceptionally Heat Stable—Excellent Permanence—Exceedingly Easy to Disperse*


CADMIUM RED
PIGMENTS
Cadmium Lithopones
ORANGE RED No. 70 LIGHT RED No. 80
MEDIUM LIGHT RED No. 90 MEDIUM RED No. 100
DARK RED No. 110 MAROON No. 120
BLEED PROOF
CADMIUM YELLOW
PIGMENTS
Cadmium Lithopones
PRIMROSE No. 20 LEMON No. 30
GOLDEN No. 40 ORANGE No. 50

# THE HARSHAW

## CHEMICAL CO.

*Cleveland 6, Ohio*

SAMPLES and COLOR FOLDER showing full range of Yellows and Reds, CP and Lithopone *will be gladly furnished on request*

Chicago
Cincinnati
Cleveland
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Hastings-on-Hudson
Houston
Los Angeles
Philadelphia
Pittsburgh

HARSHAW

# these thermatic Series* extruder

## features mean higher production on every job!

Simplified one piece cylinder with integrally cast-in Xalloy liner.

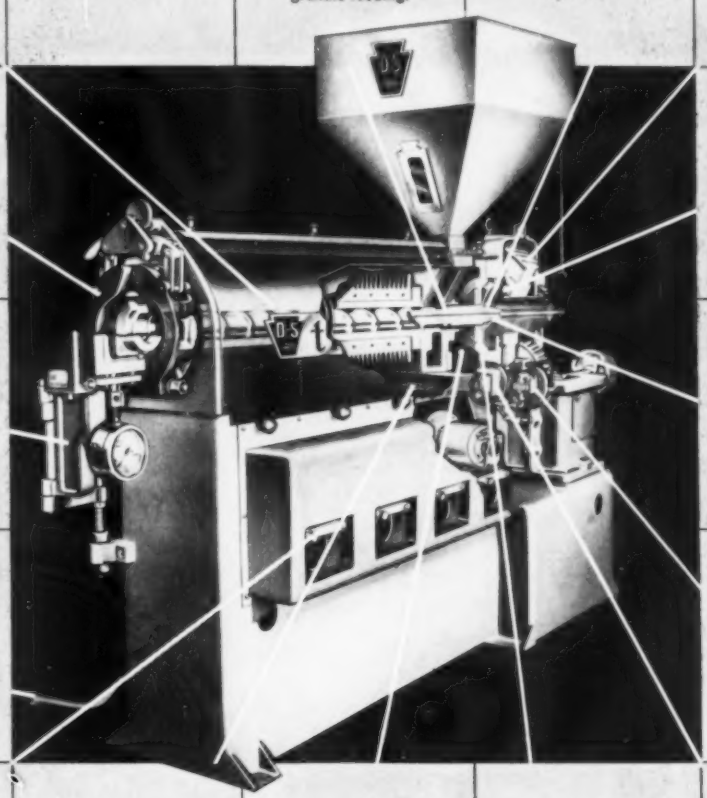
Extra large capacity stainless steel hoppers.

Screw flight extends back beyond the feed throat opening for improved powder and granule feeding.

Four-spline screw drive eliminates the eccentric screw rotation of a single key drive.

Helical gearing — smooth, efficient, free-running. Greatly increased horse-power capacity.

New stronger head clamp. Simplified opening and closing of head with positive safety shear pin arrangement.



Higher thrust bearing capacity. Extra-heavy separate thrust and radial bearings handle their respective loads individually to meet constantly increasing production requirements.

Improved hinged head support swings completely clear of the front of the extruder.

Tapered drive end of stock screw positively centers screw and simplifies removal.

Heaters and controllers completely wired for fast inexpensive installation.

Gear type oil pump, positively driven from input shaft, lubricates all bearings and gears regardless of speed.

Damper arrangement provides several gradients of natural draft cooling. Blowers provide high circulation for stubborn cooling jobs.

Air-tight oven effect adjustment by new second set of dampers for high temperature extrusion.

Access opening allows easy replacement of bronze feed throat bushing.

Labyrinth oil seals — simple non-wearing design. No oil seals or rings to replace.

Built-in direct drive stock screw electric tachometer.

Greater cylinder lengths standard on all extruder sizes with optional L/D ratios available. **2½", 3½", 4½", 6" and 8" models available.** The New D-S thermatic Series Extruders will outproduce — size for size — any other extruder on the market today. For complete specifications and details write to:

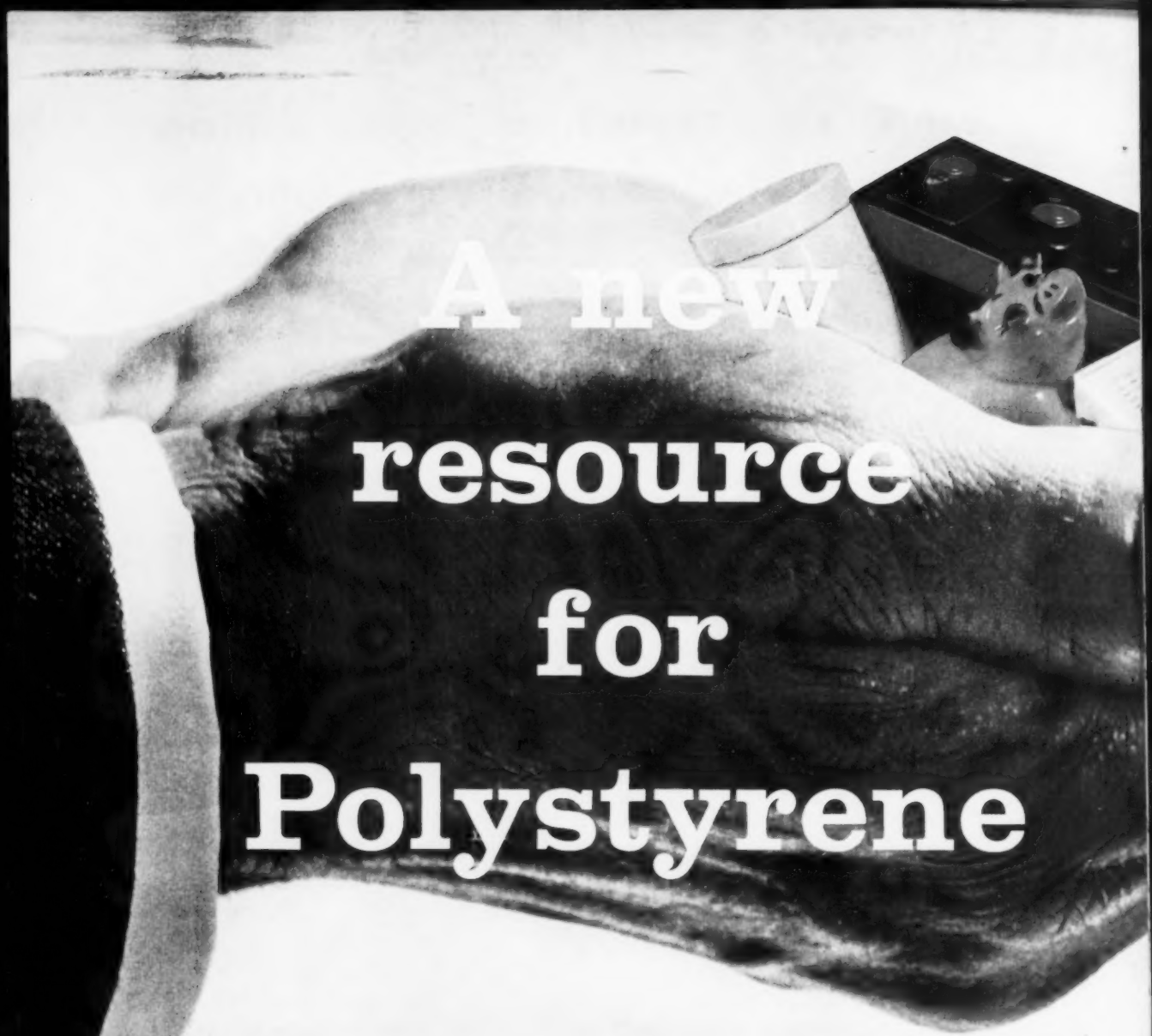
**DAVIS - STANDARD**

Division of FRANKLIN RESEARCH CORPORATION

16 WATER STREET, MYSTIC, CONNECTICUT

*Patented

In Europe and the Sterling Area contact Fawcett, Preston & Co. Ltd., Bromborough, England.
In the Mid-West contact C. J. Beringer Co., 5667 Milwaukee Ave., Chicago 46, Illinois.
In California, Oregon and Washington contact Ed. J. Lynch, P.O. Box 3043, Santa Ana, California.



# A new resource for Polystyrene

High impact and conventional Polystyrene plastic molding compounds will be manufactured by Amoco Chemicals at Joliet, Illinois. Large-scale commercial manufacturing facilities will go on stream in late 1961. Quantities for customer evaluation will be available from a product development plant also underway and scheduled to be completed by mid-1960.

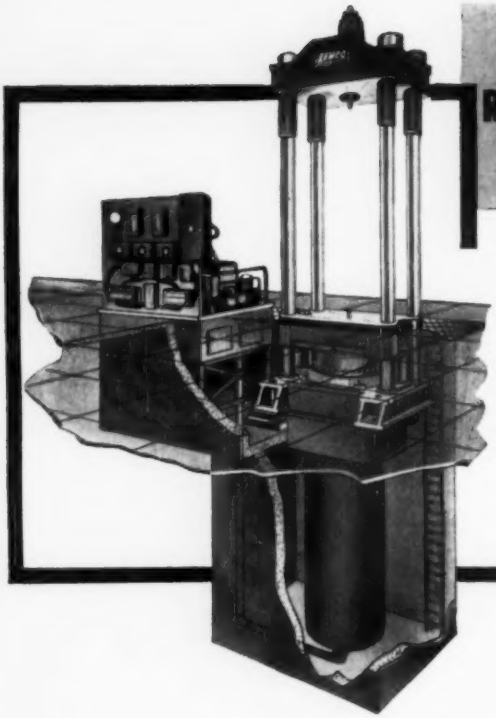
In addition to these manufacturing facilities, Amoco is establishing a comprehensive technical service program to assist customers in the use of AMOCO Polystyrene. Research which has preceded the launching of this Polystyrene program will be expanded so that Amoco may continue to make important contributions in the field of polymer chemistry.

These production, technical service, research and other facilities are a multi-million dollar extension of Amoco Chemicals' plan for becoming a new resource to industry. If you mold or use Polystyrene, watch for further information about the progress of this Amoco Chemicals project.

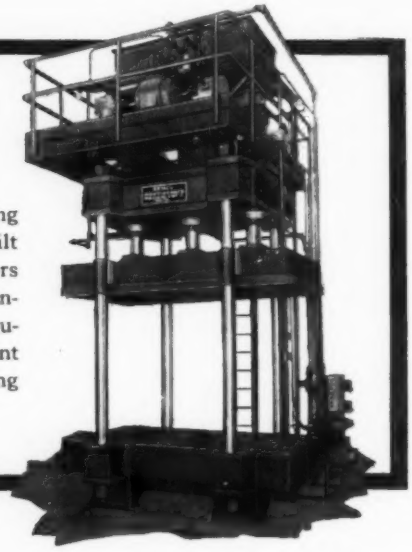
AMOCO CHEMICALS CORPORATION, 910 S. Michigan Ave., Chicago 80, Ill.

AMOCO
CHEMICALS

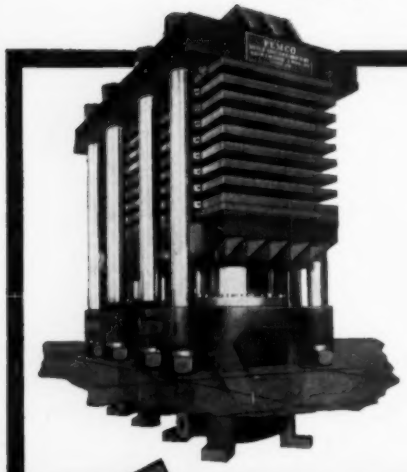
# HYDRAULIC PRESSES for the RUBBER • PLASTICS • REINFORCED PLASTICS and ALLIED INDUSTRIES



This 1,000 ton press and hydraulic system, which is 40½ feet high, was custom designed and built by EEMCO for a special application in the unprecedented time of 22 weeks—less than half the time normally needed to design and build a press of this size and complexity.



Downward acting reinforced Plastics Molding Press (standard and custom designed) —built by EEMCO to suit a specific need. Our engineers have worked with one of the pioneers in reinforced Plastic Molding, developing and manufacturing the first complete line of equipment designed especially for this rapidly growing industry.



Heavy duty Laminating Presses—multiple opening presses for laminating, press polishing, printed circuits, etc., designed for low deflections to insure uniformity of product with minimum production loss, can be equipped with automatic temperature and cycle controls. Available in any required size.

*For more information and specifications—please send for this complete folder . . .*

EEMCO

ERIE ENGINE & MFG. CO.

950 East 12th St., ERIE, PA.

*. . . designers and builders of a complete line of MILLS and PRESSES*

# U.S.I. POLYETHYLENE NEWS

A series for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins


## Packaging Notes

**New polyethylene bag-making machine** is capable of sealing polyethylene film up to 10 mil thick. The machine reportedly has better temperature control instrumentation than conventional machines. Sealing bar pressure is controlled pneumatically. Control of pre-dwell, dwell, and post-dwell times is by separate timers and the film is sealed in a completely relaxed state.

The machine can convert both blown tubing and flat film into bags. Its production rates are said to be comparable to other bag making machines.

---

**Wafer-thin snap fasteners for polyethylene envelopes** are now finding use in packaging retail soft goods. The fastener keeps the package closed, protecting the product, yet allows the customer to inspect the packaged product.

---

**Freeze-it-yourself popsicles** packaged in polyethylene-coated cellophane are now on the market in some parts of the country. The popsicles are sealed in pouches in liquid form for freezing at home. After freezing, the popsicles may be separated from each other and eaten by squeezing them out of the pouch. No sticks are needed. The film, cellophane with a 2-mil coating of polyethylene, is supplied in both printed and unprinted webs, generally four across for twin popsicles. The cellophane is printed before coating with polyethylene, locking in the printing.

---

**Label adhesive** for plastic surfaces is said to stick where average adhesives will not hold. It reportedly replaces pressure sensitive adhesives, which are slower and more costly to apply.

The adhesive is waterproof and permanently flexible. It will adhere to polyethylene, yet can easily be removed. The adhesive is applied by brush or automatic machine.

---

**Polyethylene toothpaste tube** has been developed. It is produced by an extrusion-injection molding method. A special coating is said to guard against loss of flavor and essential oils by permeation.

---

**New flexible polyethylene bag** with a sealed-in plastic tube serves as a "drink-from-the-package" container for fruit and vegetable juices, milk, soup, and soft drinks. The ready-to-use container simplifies disposal problems, speeds cooling, and is suitable for use in vending machines.

## U.S.I. Develops Three New Resins With Improved Coating Properties

### New PETROTHENE Resins Have Better Adhesion, Reduced Neck-in

U.S.I. has announced the availability of three new PETROTHENE polyethylene resins especially suited to paper coating. These new resins were developed in U.S.I.'s Polymer Service Laboratories and have successfully undergone extensive field testing.

The new resins show a marked improvement in adhesion to paper and other substrates. They also have shown reduced neck-in, smoking and polymer build-up at the die.

Neck-in, in particular, has been a troublesome problem in paper coating. It occurs when edges of the hot polymer web "neck" inward, carrying a thickened bead onto the paper. Neck-in results from a combination of resin properties and extrusion conditions. The new resins minimize the polymer's role in causing neck-in.

The resins are recommended for extrusion in the 575°-600°F. range, and cover a wide range of coating weights as shown in the chart at left.

U.S.I. COATING RESINS

| PETROTHENE Resin | 203-2 | 201-2 | 200-2 |
|---|---|---|---|
| Melt Index | 8.0 | 5.0 | 3.0 |
| Density | 0.915 | 0.915 | 0.915 |
| Coating Weight | 3-15 lb. per 3,000 sq. ft. | 10-25 lb. per 3,000 sq. ft. | 20 lb. or greater per 3,000 sq. ft. |

## Polyethylene-Coated Cup Is Tasteless, Odorless

A polyethylene-lined paper cup for hot drinks is reported to be completely tasteless and odorless. The coating eliminates sidewall staining and penetration.

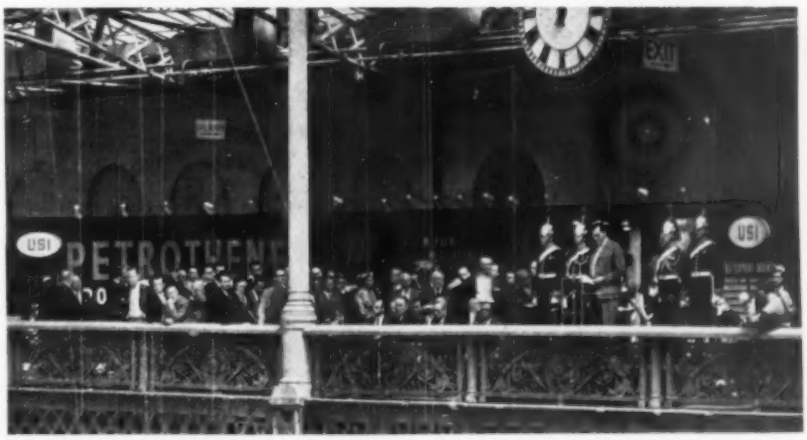
While ordinary plastic-coated paper cups are sprayed with material after they have been formed, the new cup is constructed from paper pre-coated with polyethylene. No glue is used in construction. The polyethylene itself serves as a seal for the seam and bottom, creating a bond that cannot be separated without tearing the fibers of the paper. The coating is said to be bonded firmly enough to the substrate to permit water to be boiled in the cup without damage to the cup lining.

The single wrapped cup nests closer — saving about one-third of the storage space normally required. The cup is available in six and eight ounce sizes, with or without handles.

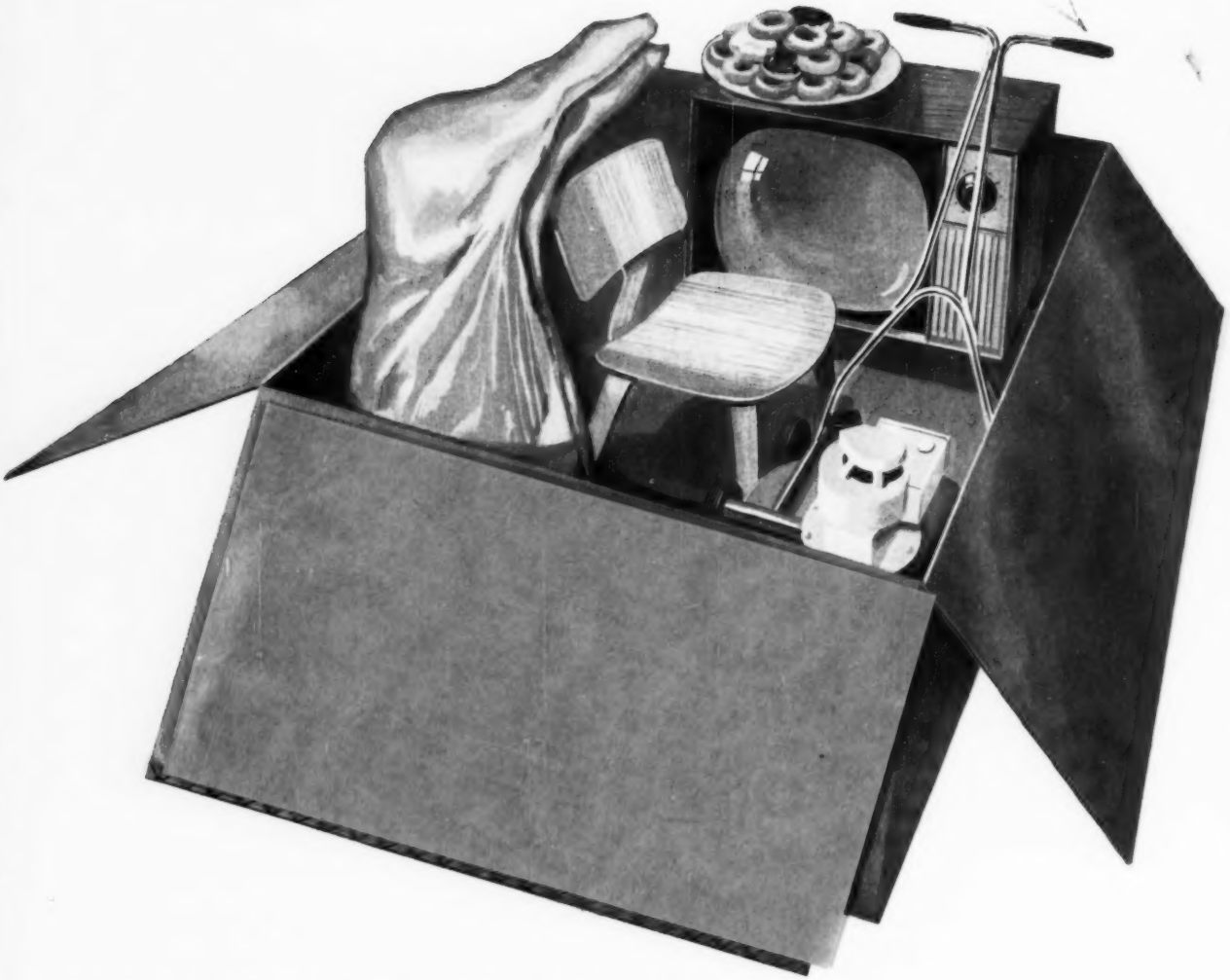
## New Package For U.S.I. Electrical Grade Resins

U.S.I. electrical grade PETROTHENE polyethylene resins are now being packaged in fifty-pound bags made of 10-mil polyethylene upon request. The bags provide added protection from moisture for the carbon-black compounded electrical resins which tend to pick up water vapor from the air.

## U.S.I. at the International Plastics Exhibition




U.S.I.'s booth at the International Plastics Exhibition was the background for the opening ceremony, June 17th in Grand Hall, Olympia, London. Above, the Exhibition is being addressed by The Right Honourable Reginald Maudling, Paymaster-General, who stands between trumpeters of the Royal Horse Guards.



exceptional moisture and grease resistance

# POLYETHYLENE-COATED KRAFT OPENS UP NEW OPPORTUNITIES FOR CORRUGATED BOARD

Polyethylene-coated corrugated board — produced on conventional corrugating equipment — is extending the usefulness of corrugated into many new packaging applications.

This unique container board has exceptional moisture and grease resistance and a glossy, non-abrasive liner surface that will not scratch or mar package contents.

Extruders who produce polyethylene-coated kraft liner board can get these extra advantages by using U.S.I. PETROTHENE® polyethylene resins:

**HIGH PRODUCTION RATES**—PETROTHENE resins have good drawdown properties, permit extrusion at high speeds.

**EXCELLENT ADHESION** — with minimum hot melt oxidation.

**NO ODOR** — an important consideration in many packaging applications.

Contact U.S.I. for information on PETROTHENE resins especially suited for coating kraft liner board.

**Packagers are investigating polyethylene-coated corrugated board for applications like these:**

Bulk shipment of meat, where moisture and grease-proof interiors reduce weight loss of the meat and keep moisture from weakening the carton.

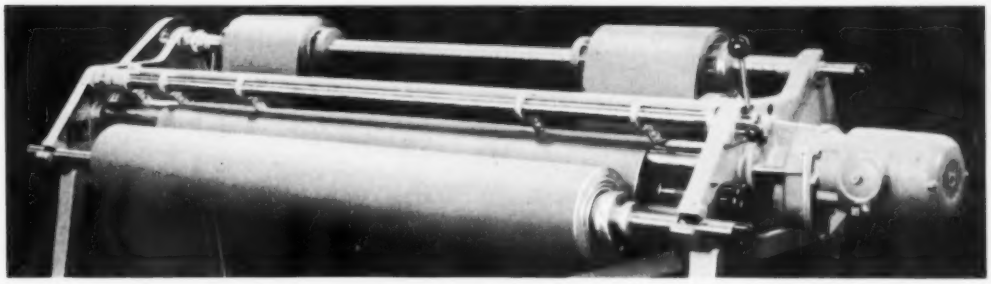
Shipment of furniture and other hard goods, where abrasion damage from the container has been a problem.

Bulk bakery and confectionery shipments, where absence of grease-wickage makes containers suitable for reuse as point-of-sale displays.

In concrete construction forms, where the polyethylene coating acts as a release agent.

**U.S.I. INDUSTRIAL CHEMICALS CO.**
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
*Branches in principal cities*

# PRECISION SLITTER



**A Precision built slitter for plastic film or sheet at ONE HALF the price you'd expect to pay.**

FEATURES OF SLITTER MODEL KRS 1450:

All rolls are wound under controlled tension — individually and independently.

Neatly wound rolls even for very narrow strips result *EVERY TIME!*

Traction, for each shaft, is always adjustable separately.

Feed roller is equipped with a readily adjustable spring-action conical brake.

Feed and take-up rollers are easily exchanged and provide for further fast and efficient servicing.

Twin take-up shafts! Constant and accurate cutting speed! Noise-free operation!

Automatic yardage meter!

**LEEDPAK INC.–294 FIFTH AVENUE–NEW YORK 1, N. Y.**

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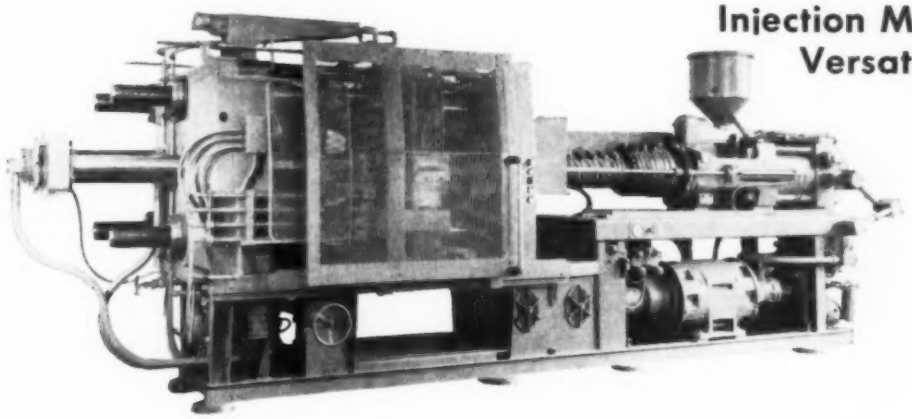

## Injection Molding's Most Versatile Performer!

IMPCO

*Announcing* the new 20 ounce Impco

**Model HA16–425** — **720 Dry Cycles Per Hour**

**200 Pounds Per Hour Plasticizing Capacity**

**24½ Inch Stroke** — **Hydraulic Knockout**

**IMPROVED MACHINERY INC.** NASHUA, NEW HAMPSHIRE

In Canada, Sherbrooke Machineries Ltd., Sherbrooke, Quebec

*Export Distributors:* Omni Products Corp., 460 Fourth Avenue, New York, New York

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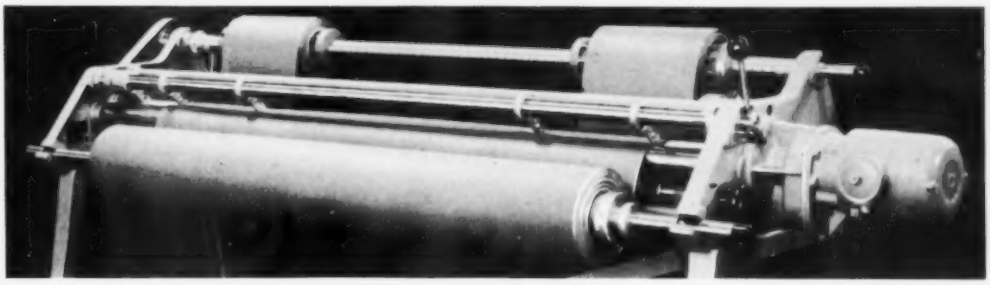

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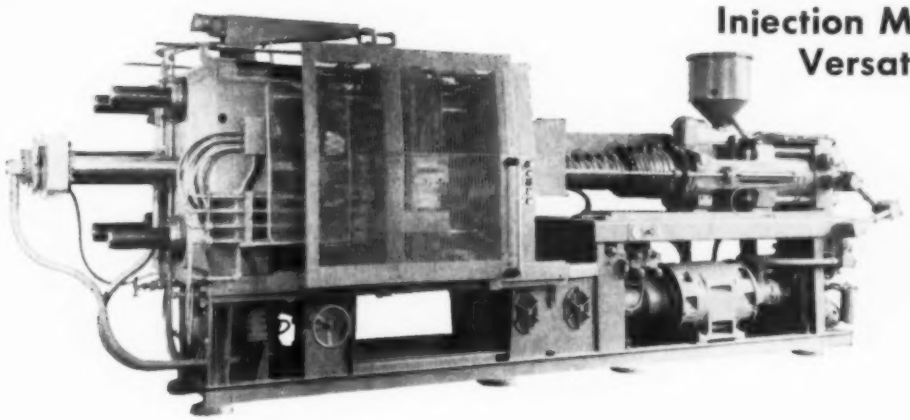

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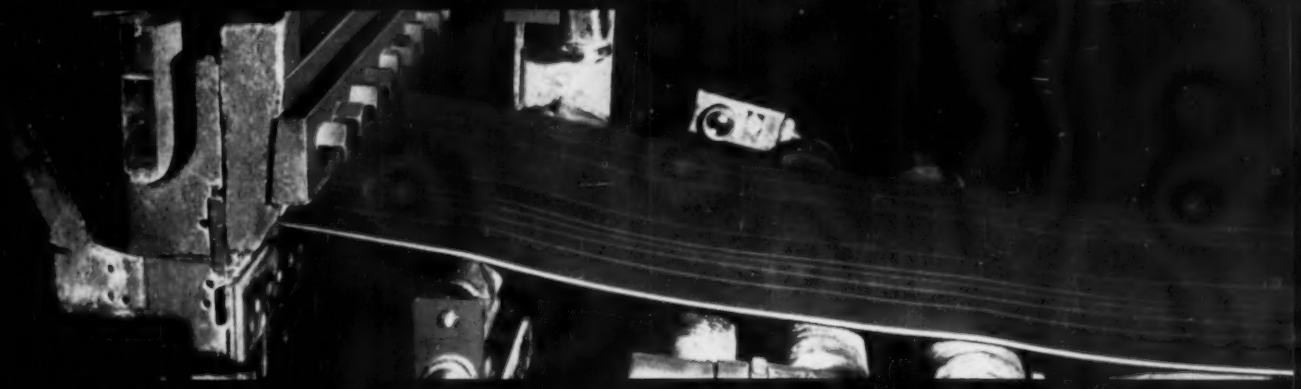
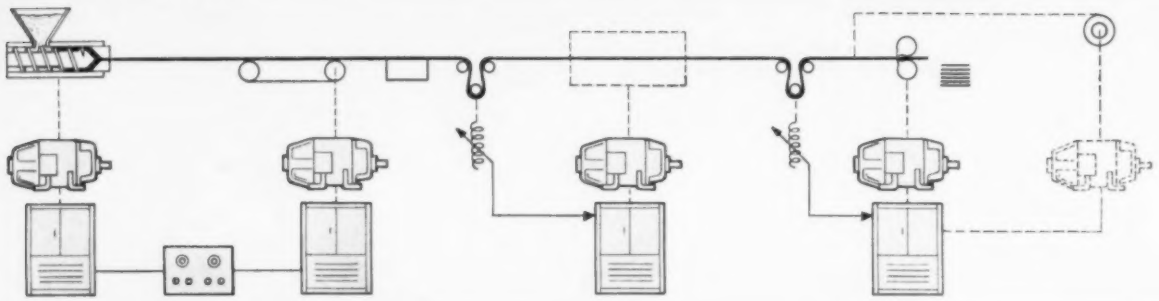
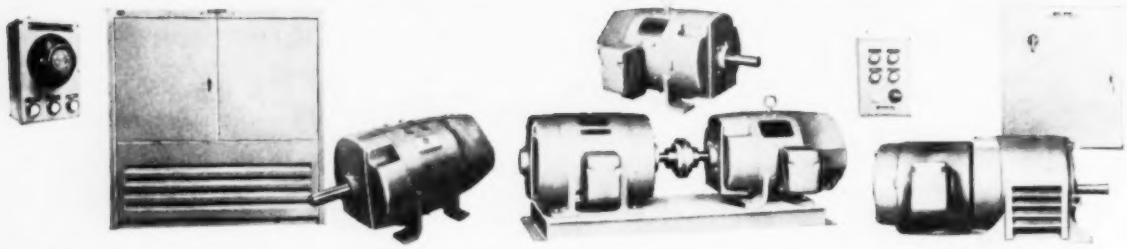


# General Electric Extruder Drives Offer Greater Efficiency



## At Payload Operating Speeds, Help Build Extruder Profits



SPEED VARIATOR PACKAGED DRIVES

KINAMATIC® MOTORS AND M-G SETS

KINATROL*
EDDY CURRENT COUPLING DRIVES

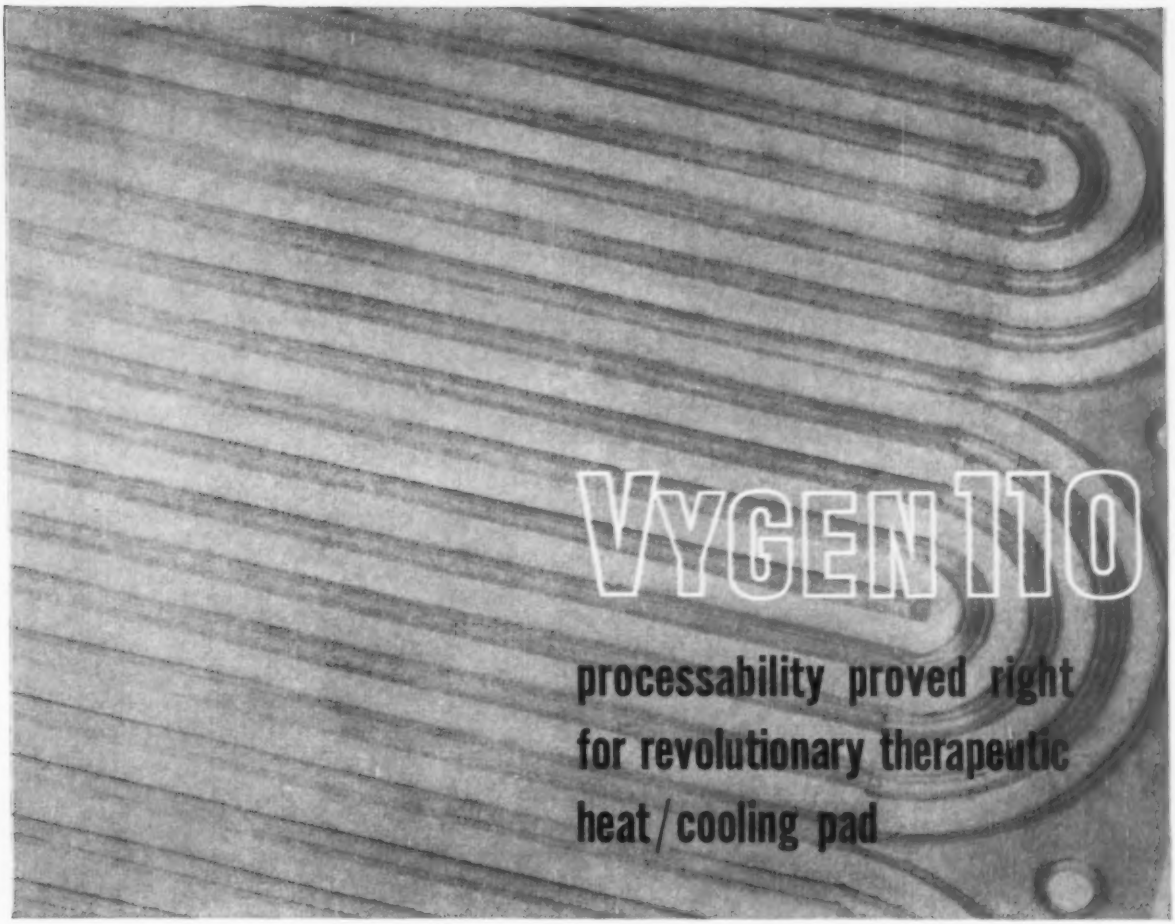
*Trade Mark of General Electric Company

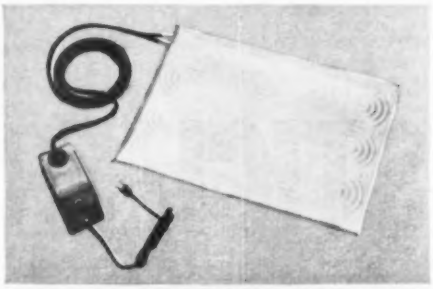
## MODERNIZE FOR PROFITS

***You can turn power costs into profits with a G-E Speed Variator extruder drive.*** Compared with a major competitive drive, a 100 hp Speed Variator—operating at speeds most widely used in extruding—can save up to $700 each year per 8 hour shift—$2100 annually for a 3 shift operation in power costs alone. Lower cost installation and improved maintenance features offer other substantial savings.

For more information on how G-E drives provide greater extruder flexibility, better quality control, higher output and efficiency, call your nearby G-E Apparatus Sales Office, and send for a helpful *Extruder Drive Selection Kit.* For your free kit, write Section 822-3, General Electric, Schenectady 5, New York.

GENERAL ELECTRIC



aquamatic K-pad is a water circulating heat/cooling hospital pad with temperature ranges from 34°F to 105°F. . . . used for body temperature control in low temperature surgery. Specific requirements: low moisture absorption, flexible and soft at low temperatures, easy to clean — sanitary, and non-staining. Designed and manufactured by Gorman-Rupp Industries, Inc., Bellville, Ohio. Sheeting specially compounded and extruded by Conneaut Rubber & Plastics Company, Conneaut, Ohio.

Vygen 110 is not just another quality resin, but one of a family of specialized PVC resins developed and manufactured to meet the requirements of the processor and the demands of the end product. No matter what your processing requirement, you should look to the VYGEN family for PVC resins *just right* for every application.

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*Creating Progress Through Chemistry*

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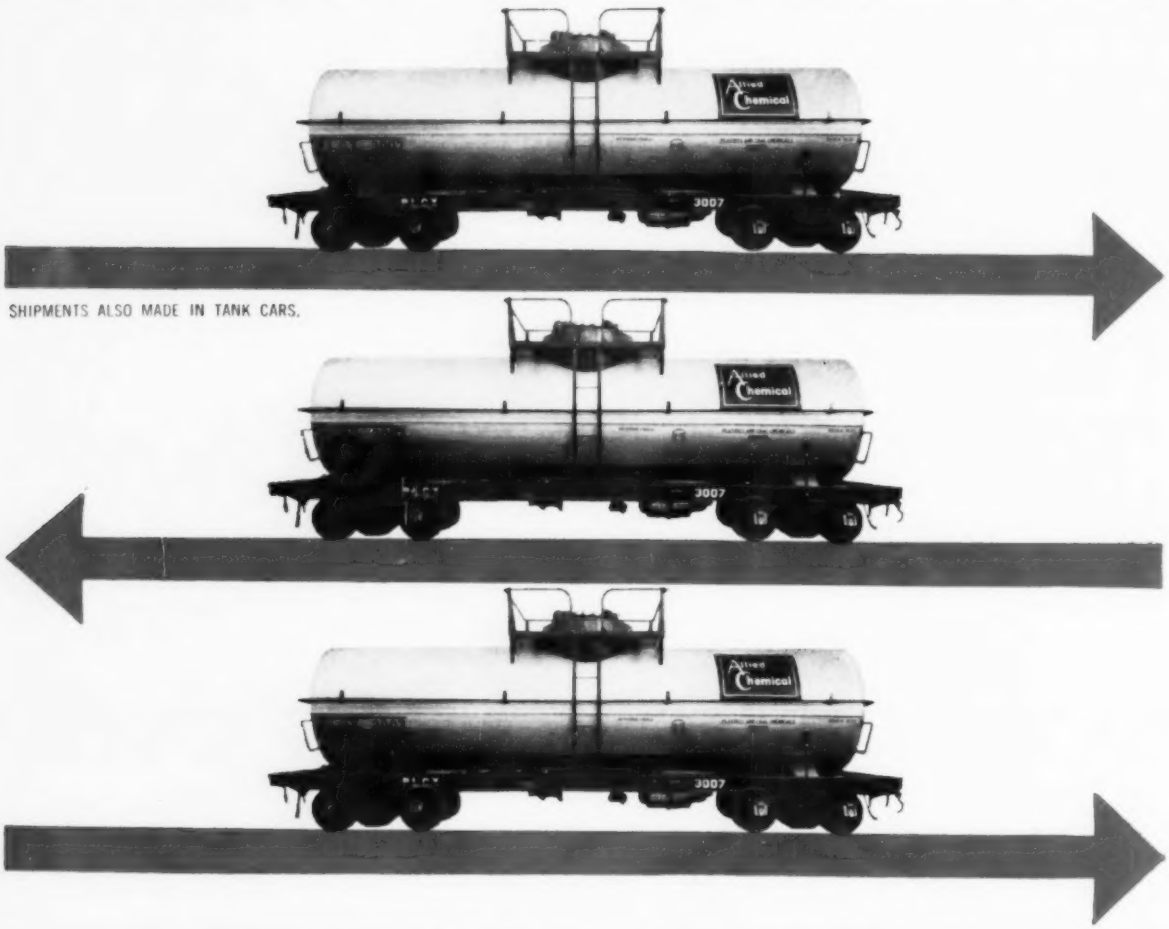
...now made in Toledo, too, for added stability of supply that enables you to cut costs by cutting your inventory




# ELASTEX® PLASTICIZERS

Plastics and Coal Chemicals Division can offer you a complete line of pure plasticizers for plastics, rubber, paints and lacquers. You can have complete confidence in their stability of supply, too, because "ELASTEX" Plasticizers are now manufactured at our new facility in Toledo, Ohio, as well as in our plant in Philadelphia (Frankford), Pa.

Let Plastics and Coal Chemicals Division help you cut costs by carrying your plasticizer inventory for you. Efficient handling and shipping in modern stainless-steel tank trucks assure next-day delivery from any of 9 key cities. Just phone the office nearest your plant:

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|---|---|---|---|
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| Buffalo | Delaware 3600 | Los Angeles | Raymond 3-1371 |
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| Cleveland | Henderson 2-2020 | Philadelphia | Jefferson 3-3000 |
| Detroit | Vinewood 2-4400 | | |

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**PLASTICS AND COAL CHEMICALS DIVISION**
40 Rector Street, New York 6, N. Y.

Allied Chemical

Many compounders are now taking advantage of rugged ROYLE SPIROD Extruders in their operations. Check these features:

**1**

*New dual head arrangement for reclaiming or coloring procedure; allows continuous operation while fixtures and screens are cleaned.*

**2**

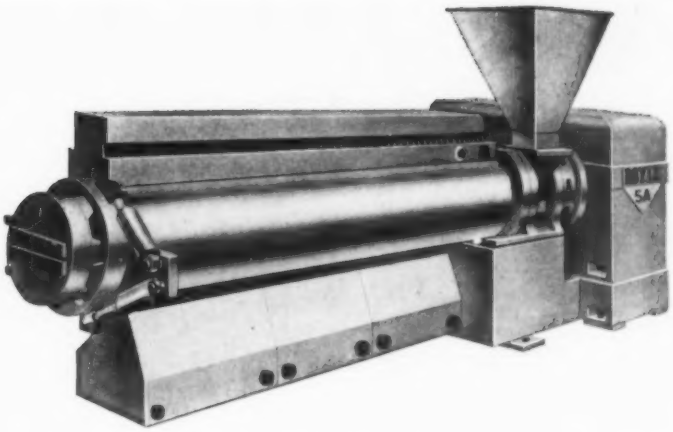
*Thrust bearings with positive internal lubrication, designed for 10 years' minimum life.*

**3**

*New positive seal at stockscrew shoulder to prevent compound leakage with powder feeds.*

**4**

*Evaporative cooling system particularly effective for melt-fed polyethylene processing extruder.*



# Royle Spirod Extruders allow continuous, economical operation

## JOHN ROYLE & SONS

*Pioneered the Continuous Extrusion Process in 1880*

**London, England,** James Day (Machinery) Ltd., Hyde Park 2430-0456. **Home Office,** V. M. Hovey, J. W. VanRiper, SHerwood 2-8262. **Akron, Ohio,** J. C. Clinefelter Co., BLackstone 3-9222. **Downey, Cal.,** H. M. Royal, Inc., TOpaz 1-0371. **Tokyo, Japan,** Okura Trading Company, Ltd., (56) 2130-2149.

**ROYLE**

Paterson, N. J.

**John Royle & Sons, 6 Essex Street, Paterson 3, New Jersey**

*Please, send me full information about Royle Spirod Extruders.*

**Name** _____ **Title** _____

**Company** _____

**Street** _____

**City** _____ **Zone** _____ **State** _____

*As they have been since 1880, Royle is first in Extruder development.*

Periodic Chart of the Atoms, Copyright W. M. Welch Mfg. Company, Chicago

# CURIOSITY THAT'S BRED IN THE BONE

There's a hidden ingredient in every Argus product. It's the basic, bred-in-the-bone curiosity about your problems that enables Argus research to keep turning out better and better vinyl plasticizers and stabilizers at lower and lower cost.

Many of Argus' superior products have been developed, or improved, in the course of finding answers to specific technical problems posed by customers. The reason: every member of the Argus research staff is a recognized authority in the vinyl field.

If you want the *right* answers, ask Argus. We'll find them for you in our regular line of Mark stabilizers and Drapex plasticizers — or in basic, original research done on your product by our Technical Service Staff. Write for technical bulletins and samples.

**ARGUS CHEMICAL CORPORATION** / New York and Cleveland

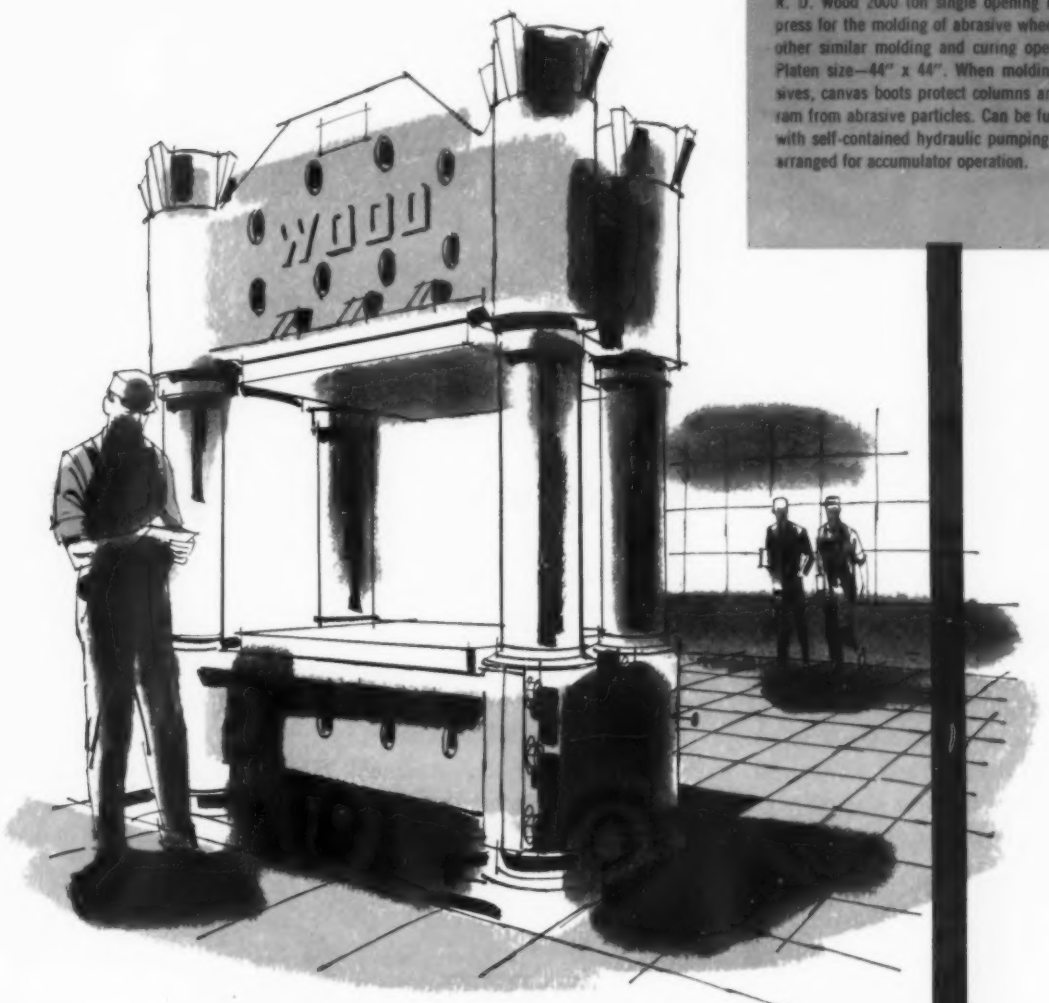
Main Office: 633 Court Street, Brooklyn 31, N. Y. Branch: Frederick Building, Cleveland 15, Ohio

Rep's.: H. M. Royal, Inc., 11911 Woodruff Ave., Downey, California; Philipp Bros. Chemicals, Inc., 10 High St., Boston; H. L. Blachford, Ltd., 977 Aqueduct St., Montreal.

## *How to save money on your next press: apply your specs to a basic R. D. Wood design*

The result will be exactly *what you want*—just as surely as if you had it designed from scratch. And its cost will be much lower. Working with numerous basic models, R. D. Wood engineers can save considerable design time and expense, and still incorporate *your* specifications in the finished machine. You're sure of its quality, too. For every Wood Press is built by experts using selected materials. This brings additional saving from smooth, dependable performance; fast, economical production; trouble-free operation. *Before* you begin planning your next hydraulic press, consult Wood.

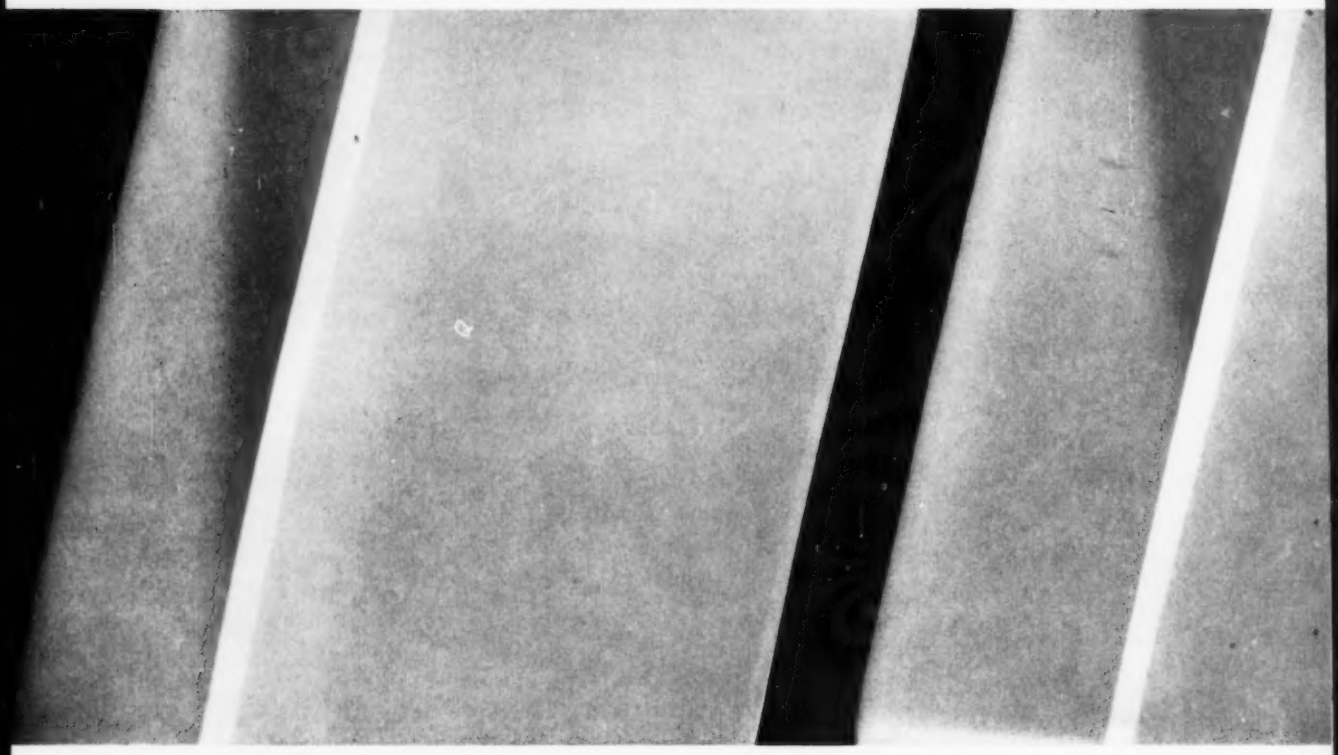
R. D. Wood 2000 ton single opening molding press for the molding of abrasive wheels, and other similar molding and curing operations. Platen size—44" x 44". When molding abrasives, canvas boots protect columns and main ram from abrasive particles. Can be furnished with self-contained hydraulic pumping unit or arranged for accumulator operation.




**R. D. WOOD COMPANY**

PUBLIC LEDGER BUILDING • PHILADELPHIA 5, PENNSYLVANIA

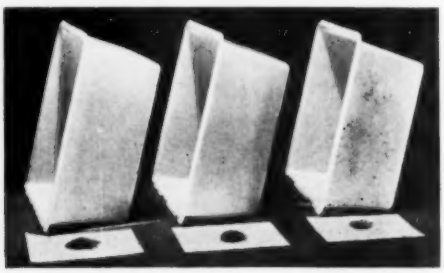
# Which polyethylene



## *UNION CARBIDE brings you two new polyethylene molding materials*

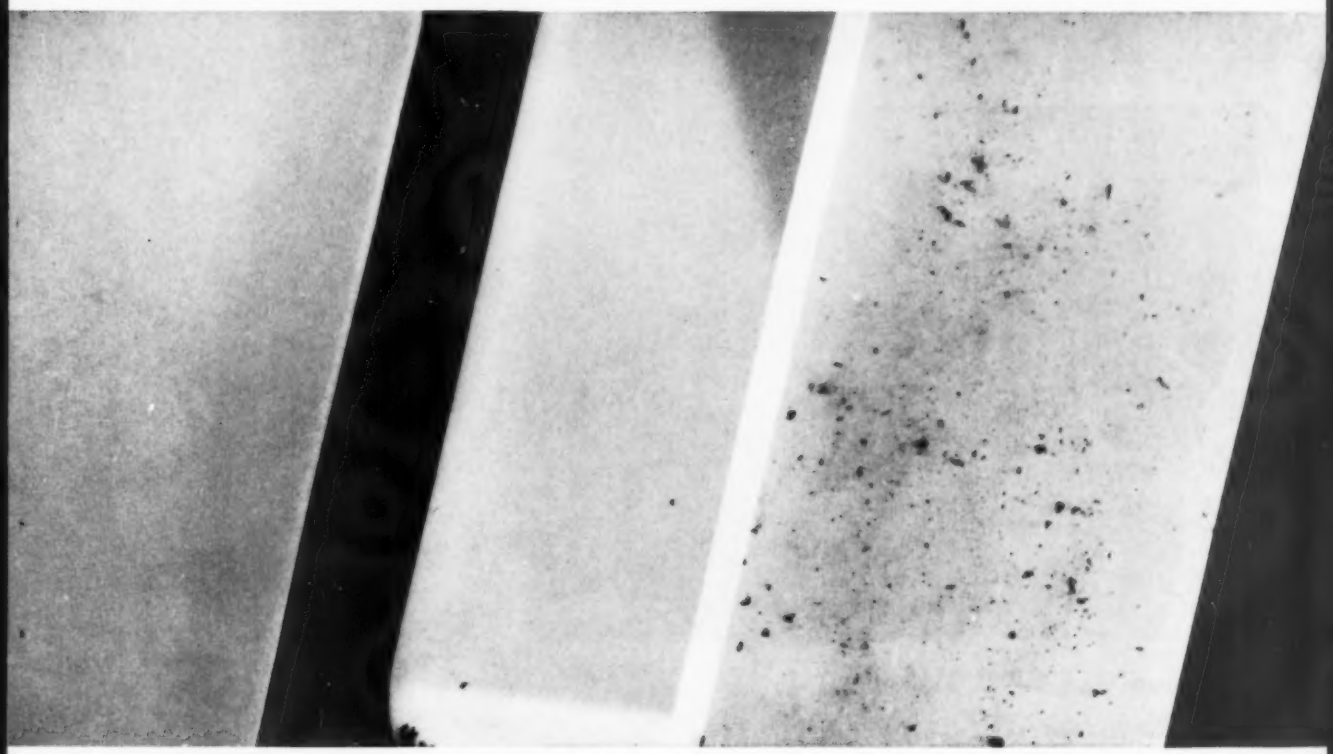
This new benefit is engineered into two BAKELITE Brand Polyethylenes—DNDA-0401 and Polyethylene Copolymer DPD-7366 Think of what this means in saving of time for retail stores, where conventional polyethylene articles take hours of constant dusting ... and the more they're wiped, the more dust they attract! Now, colors stay bright and surfaces sparkle, Housewares made with anti-dust polyethylene are *always* ready with sales appeal.

BAKELITE polyethylene DNDA-0401 and DPD-7366 possess all the other desirable properties of high-quality polyethylene housewares compounds. DPD-7366 is based on the new polyethylene copolymer recently introduced by Union Carbide Plastics Company to the molded-housewares industry. As such, it has excellent low-temperature toughness and improved rigidity in addition to its anti-dust properties. DNDA-0401 is a high flow gen-



After being wiped clean, dishpans made from new anti-dust polyethylene stay dust-free (left), while conventional one picks up cigarette ash immediately.

# doesn't attract dust?



***that do not attract dust . . . and help keep housewares clean.***

eral purpose, anti-dust, housewares material with more flexibility than DPD-7366, in molded housewares items.

Find out which is best for you—and for your sales. Write for information to Dept. Q-52G, Union Carbide Plastics Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 7

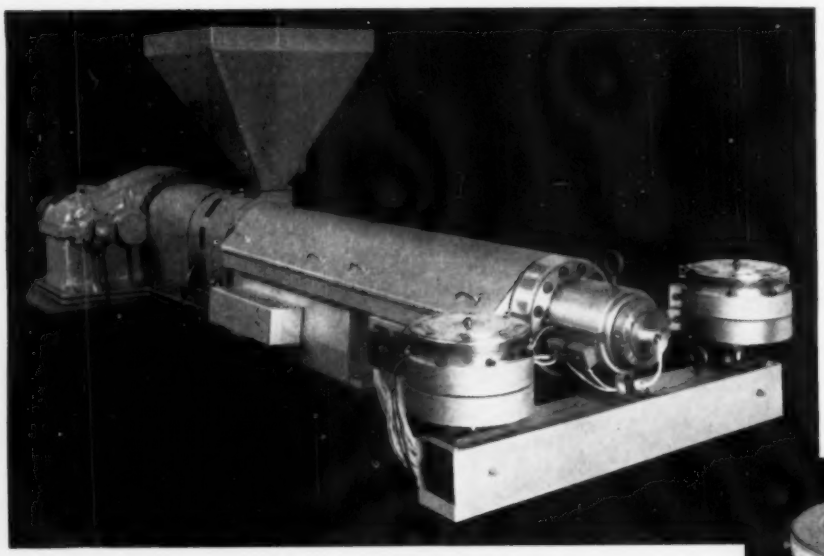
**TYPICAL PROPERTIES**

| | DPD-7366 | DNDA-0401 |
|---|---|---|
| Melt index g/10 min. | 8 | 25 |
| Secant modulus, psi at 23°C | 40,000 | 29,000 |
| Tensile strength, psi | 1600 | 1420 |
| Elongation, % | 210 | 134 |
| Yield strength, psi | 1500 | 1320 |

UNION CARBIDE

BAKELITE and UNION CARBIDE are registered trademarks of Union Carbide Corporation.

# BEST FOR LAYFLAT TUBING



## EGAN EXTRUDERS

***Available with low base for layflat tubing installations***

Egan Extruders offer distinct advantages in any blown film installation! A low base permits extra cooling space, and easier access to dies and feed section. The manifold arrangement, illustrated on the above 4½" extruder, permits full output even when using small dies. The manifold is valved so that one side only can be used, if desired. Complete engineering data available upon request, covering the full line of Egan Heavy Duty Extruders.

## EGAN DIES

***No weld lines***
***More uniform gauge***
***Better quality film***

The Standard 24" Egan Die shown above has a center feed arrangement, incorporating a specially designed mandrel. It eliminates "weld lines," and assures uniform pressure at the die orifice. The result is a more uniform gauge and better quality film!

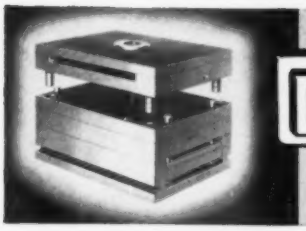
Egan Dies are available in a wide range of sizes.

Egan

**FRANK W. EGAN & COMPANY**
**SOMERVILLE, NEW JERSEY** Cable Address: EGANCO - SOMERVILLE NJER

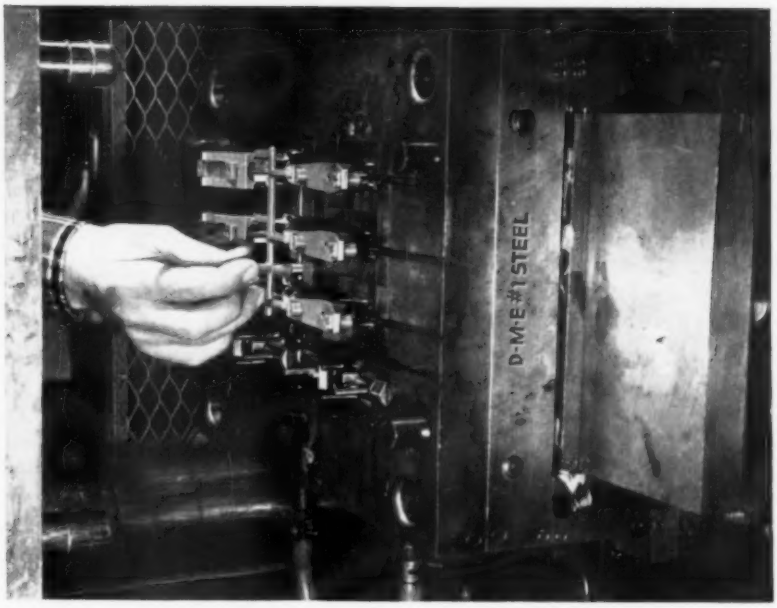
*Manufacturers of plastics extruders, dies, take-offs, and other accessories*

REPRESENTATIVES: MEXICO, D. F.-M. H. GOTTFRIED, AVENIDA 16 DE SEPTIEMBRE; JAPAN-CHUGAI BOYEKI CO., TOKYO. LICENSEE: GREAT BRITAIN-BONE BROS. LTD., WEMBLEY, MIDDLESEX.



# DME Mold Standards

DEDICATED TO QUALITY, SERVICE AND ECONOMY IN MOLDING




## YOU SAVE MORE ON MOLD COSTS WITH OVER 6,000 D-M-E STANDARD MOLD BASES TO CHOOSE FROM

### Largest Selection Saves You Time and Money

Whether it's a one-cavity "test" mold or a 60-cavity high production run, chances are D-M-E has the right size Standard Mold Base to fit the job and the molding machine.

D-M-E's 32 standard sizes, up to $23\frac{3}{4}$" x $35\frac{1}{2}$", with 100 standard cavity plate combinations for each size, give you the largest selection of carbon or alloy steel standards available from any single source.

### Save on Design Time, Moldmaking Time, Replacement Parts and Delivery

Design time is reduced by using D-M-E's full-scale Master Layouts and Catalog of specifications and prices. Moldmaking time is reduced because all D-M-E plates are precision ground flat-and-square, ready for cavity layout and machining. Exclusive interchangeability gives you the added saving of immediate replacement of any component part. And D-M-E's seven branch offices and warehouses are always fully stocked with Standard Mold Bases and components to meet your delivery requirements.

### Cut Costs on Your Next Program

Start saving on your next moldmaking program, no matter how large or small. Take advantage of D-M-E Quality, Service and Economy.

## THERE'S NO SECRET To a Fine Finish...

## ...With D-M-E's Line of Mold Polishing Supplies

Polishing mold cavities to a high lustre that is imparted to the molded piece was once "a well-guarded secret." But with D-M-E's complete line of mold polishing supplies moldmakers are able to attain the particular finish required by the part.

With D-M-E Diamond Compound, mirror finishes are produced in less time and at less cost.

Other time and money saving items for your polishing department include: D-M-E's Felt Polishing Kit, Abrasive Stones, Mold Polishing Compound, Abrasive Mounted Points and D-M-E-'s Mold Cleaner and Rust Preventive.

**START SAVING NOW** . . . Contact your nearest D-M-E Branch for full details and prices.

**FASTER DELIVERIES FROM COMPLETE STOCKS**

Over 1,000 D-M-E Standard Mold Bases always IN STOCK at local D-M-E Branches for IMMEDIATE DELIVERY.

**DETROIT MOLD ENGINEERING COMPANY**

DME

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- D-M-E CORP., CLEVELAND: 502 Brookpark Rd.—DAYTON: 558 Leo St.
- D-M-E of CANADA, Inc., TORONTO, ONT.: 156 Norseman Ave.

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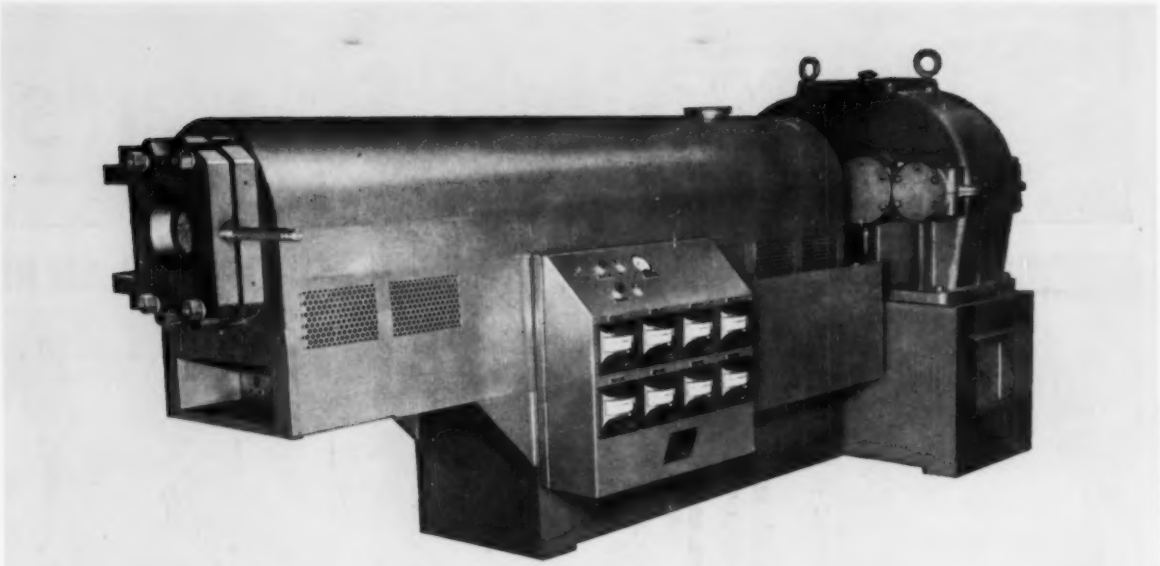


Farrel 4½" Inductomatic® extruder

# INDUCTION-HEATED EXTRUDERS

## *. . . for precise temperature control*

Farrel's line of extruding machines for the plastics industry has been expanded to include small Inductomatic extruders in a range of sizes from 2½" to 6". These are used for the extrusion of thermoplastic products such as tubing, clothesline, pipe, hose, gaskets, wire coating, blown or flat film, sheet, compounding, etc.

Extrusions produced on a Farrel Inductomatic are of consistently high quality thanks to precise heat control. The induction-heating element is air-cooled . . . individual coils are equipped with a pair of blowers as well as cooling ducts. A single automatic pyrometer controls both heating and cooling.

Faster heat-ups and changeovers mean higher production rates. Designed for maintenance immunity, these machines incorporate lifetime silicone inductors and thrust bearings with long life expectancy.

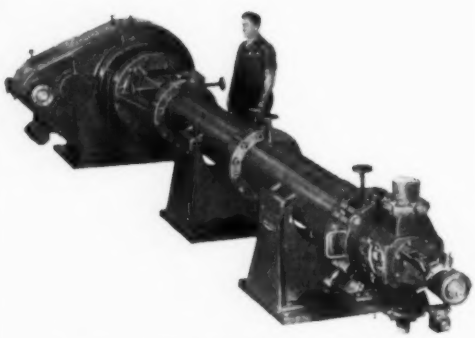
Farrel induction-heated extruders are available with optional design features and many accessories for making up "package-unit" extrusion lines. Send for full details.

**FARREL-BIRMINGHAM COMPANY, INC.**
**ANSONIA, CONNECTICUT**

*Plants:* Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
*Sales Offices:* Ansonia, Buffalo, Akron, Chicago, Ann Arbor (Mich.), Los Angeles, Houston, Atlanta

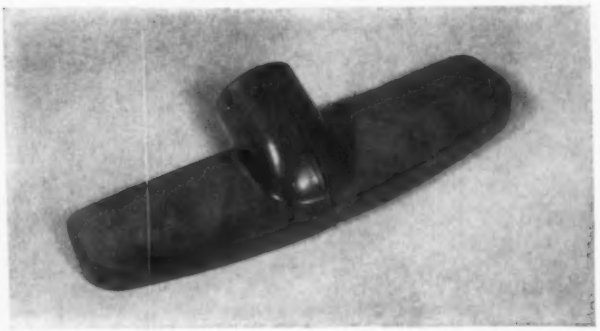
FB-1177

FARREL



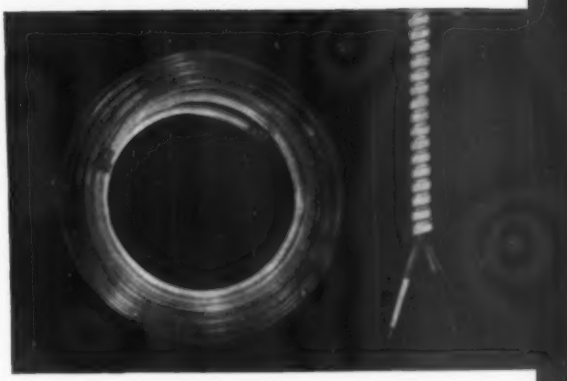
**8½" UNDERWATER PELLETIZING EXTRUDER**

Among the wide variety of large processing extruders built by Farrel to individual requirements is this cold-feed machine. It was designed to rework cold granular polyethylene with antioxidants and, with or without coloring matter, force the material through a straining screen, and pelletize it in an underwater head at a rate of 1600 pounds per hour.



# OPALON*

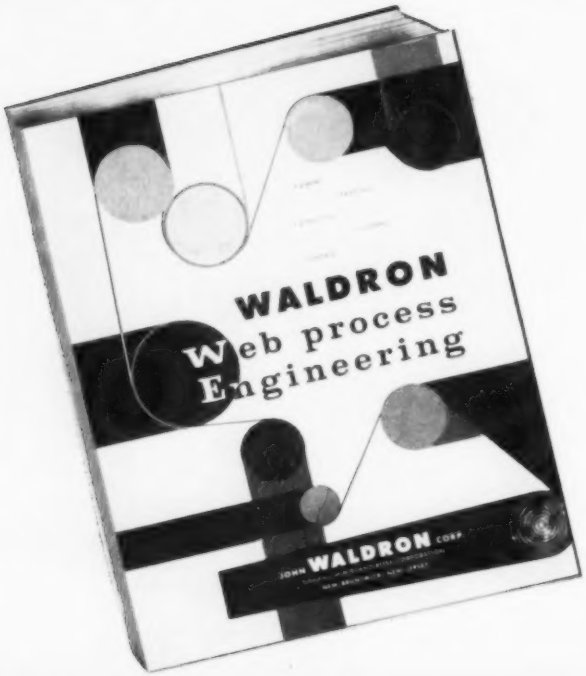
for every possible type of vinyl application



A wide range of OPALON VINYL resins and compounds have been perfected by Monsanto to meet the specific needs of molders of appliance parts, housings, toys, phonograph records, rain-wear . . . extruders of wire and cable insulation, garden hose . . . calenderers and extruders of vinyl film and sheeting . . . manufacturers of floor tile . . . coaters of textile and paper for upholstery and wall coverings . . . and compounders of plastisols for metal coating, slush-molding, foaming, and dipping. Specify OPALON vinyl—and profit from Monsanto research, experience, and productive capacity. Monsanto Chemical Company, Plastics Division, Springfield 2, Massachusetts.

Monsanto

*OPALON: REG. U.S. PAT. OFF.




# WEB PROCESSING

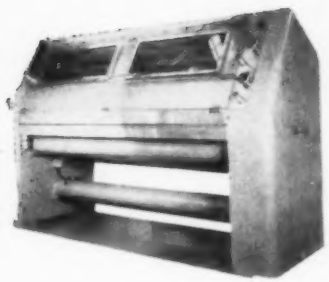
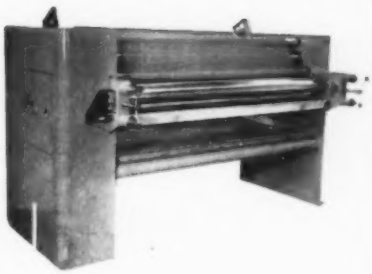
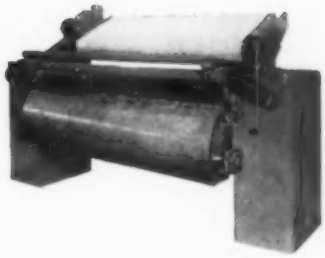
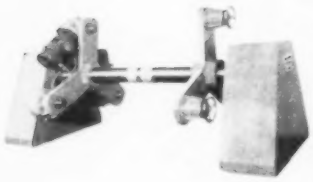
**A study of this 130 page, well-illustrated catalog will disclose three features of Waldron Service, features that mean much to the purchaser:**

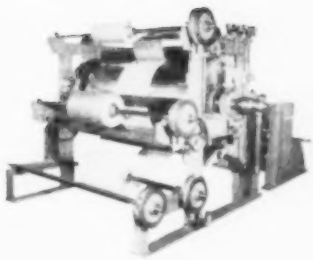
1. **exceptionally broad experience in the field of web processing.**
2. **practically every machine ordered is individually designed; Waldron machines are custom built.**
3. **auxiliary equipment also is Waldron design.**

And these three features are largely responsible for the thousands of successful web-processing installations carrying the nameplate 'Waldron.'

Waldron Engineers, in designing the equipment, take into consideration every factor involved. Since seldom are any two projects alike, it means that each design job has its distinctive variations. The processing of a *plastic* web is not an easy job under the simplest of requirements. And each new plastic material, as it comes on the market, calls for a new evaluation of all factors. To all such problems Waldron Engineers bring just about the broadest experience available, certainly the oldest experience.

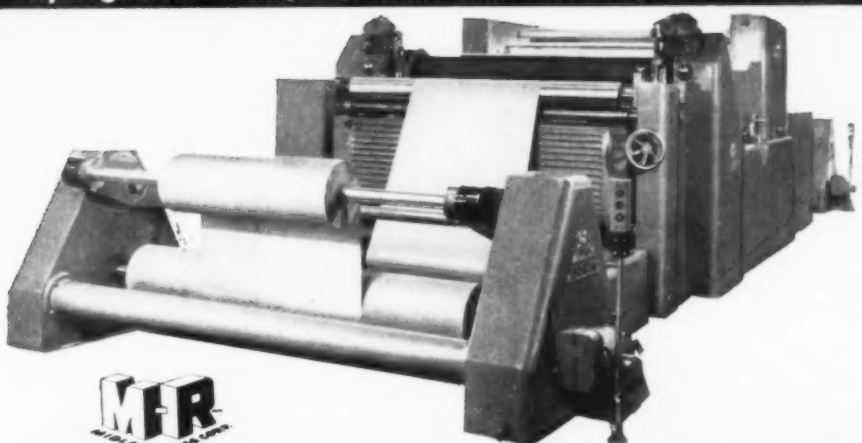
We suggest that you send for our General Catalog No. 10. If you have plans for processing webs of any kind, why not discuss them with one of our experienced Web Processing Engineers?



# MACHINERY FOR PLASTICS

*by Engineers Widely Experienced in Processing All Kinds of Webs*



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THE MIDLAND-ROSS GROUP OF COMPLEMENTING SERVICES

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John Waldron Corporation, New Brunswick, N. J.
Andrews and Goodrich, Boston
Ross Engineering of Canada Limited, Montreal
Ross Midwest Fulton, Dayton
Hartig Extruders, Mountainside, N. J.
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**JOHN WALDRON CORPORATION**

SUBSIDIARY OF MIDLAND-ROSS CORPORATION

LEADER IN WEB PROCESS ENGINEERING SINCE 1827

NEW BRUNSWICK, NEW JERSEY • MT. PROSPECT, ILL. • LOS ANGELES

WEST COAST REPRESENTATIVE: BOJANOWER MACHINERY SERVICE CO.
5270 EAST WASHINGTON BOULEVARD, LOS ANGELES 22, CALIFORNIA

DOW Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

# STUDY EMPHASIZES ENVIRONMENT AS IMPORTANT FACTOR IN LIMITING DESIGN STRENGTH (PART 2)

(This is the concluding half of a two-part article detailing the importance, and some of the effects, of environment on the performance of plastics materials. Part 1, which appeared in a recent issue of this magazine, was concerned primarily with the roles of design and environment as important, but often neglected, elements of engineering data.)

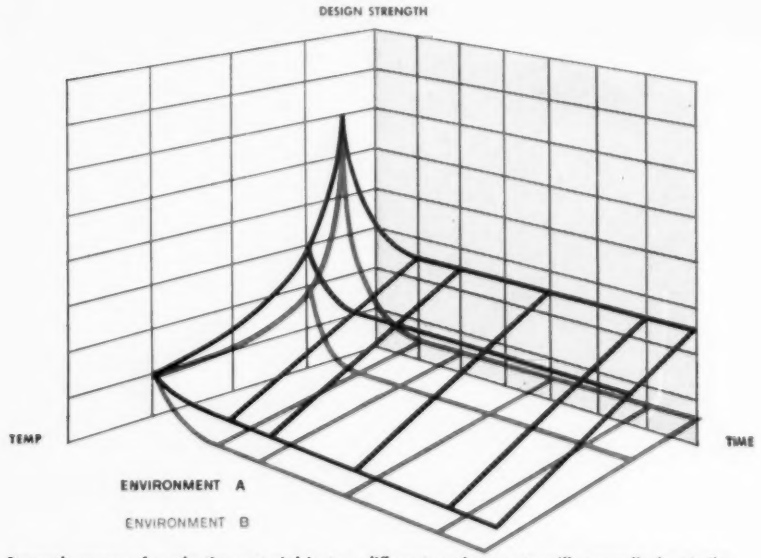
It's well known that environmental effects are commonly found in dealing with such engineering materials as metals, ceramics, and even glass. In these materials, environment sensitivity is often called "stress corrosion" or "stress corrosion cracking", and is frequently characterized by chemical reactions. Comparable failure in plastics is termed "stress cracking", though it is seldom accompanied by failure-induced chemical reactions.

In conducting this series of Plastiatrics studies, Dow Plastics Technical Service Engineers have developed evaluation methods which allow determination of environmental effects on design strength. The methods take into account time, temperature, environment and stress level; and permit the development of design data of importance to designers and plastics engineers.

It has been pointed out that environmental changes can easily reduce the design strength of plastics—that is, the stress level above which stress cracking occurs—to a point where relatively low stresses will produce failure. When a plastics material retains relatively high strength in a given environment "A", and a second environment "B" is known to reduce that plastic's strength by many times, it is seldom possible to determine the actual degree of weakening except by physical testing. However, both strength-time curves will be similar in shape. And because environmental effects are physico-chemical in nature, both curves will generally follow the rule of chemical activity increasing with temperature.

The relationship of environment to time, temperature and strength is shown by the accompanying graph, data for which was based on a completed Plastiatrics study of a Dow plastics material.

Plastiatrics studies to develop engineering data, and to investigate many phases of plastics formulation, design, molding and finishing are continually in process by Dow Plastics Technical Service Engineers. For further information on these plastiatrics studies, write THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department 2105DT9.




*Strength curves of a plastics material in two different environments will generally be similar in shape, but the relative degree of strength at any specific time-temperature point can, and usually does, vary considerably.*

AMERICA'S FIRST FAMILY OF THERMOPLASTICS

Styron*
Zerlon*
Ethocel*
Tyril*
Polyethylene
PVC Resins
Pelaspan*
Saran

*Trademark

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

# Impact strength for Polyvinyl Chloride ...with easy processing

With a new acrylic resin—ACRYLOID KM-227—processors of rigid polyvinyl chloride can now give their products unusually high impact resistance and enjoy easy processing at the same time. This modifier also provides improved flow in calendering, extruding, and vacuum forming operations.

Overmilling or reworking does not affect impact strength of rigid vinyl modified with this acrylic resin. In addition, rigid vinyl compounds modified with ACRYLOID KM-227 show good retention of impact strength upon exposure to both heat and ultraviolet light.

Processing properties of vinyl compounds may be improved still further by using ACRYLOID KM-227 together with ACRYLOID K-120. Or, for certain properties, you may find a third acrylic modifier, ACRYLOID KM-220, particularly useful. All three are available from Rohm & Haas. Write for technical bulletins fully describing their advantages in the various types of rigid vinyl processing.

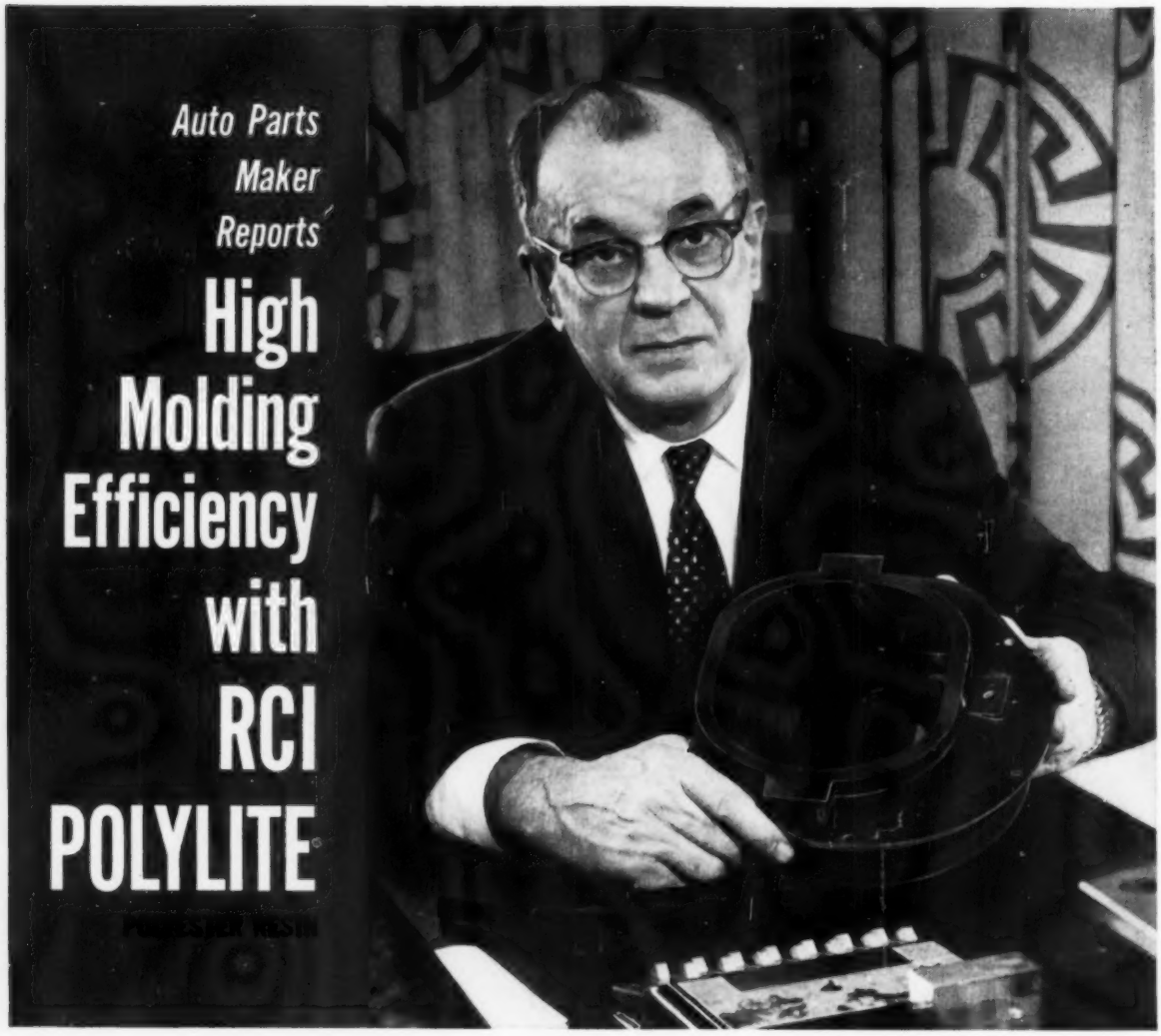
*Chemicals for Industry*

**ROHM & HAAS COMPANY**

**THE RESINOUS PRODUCTS DIVISION**

**Washington Square, Philadelphia 5, Pa.**

*ACRYLOID is a trademark, Reg. U.S. Pat. Off. and in principal foreign countries.*




## Cure Time Reduced to 42 Seconds

"With Reichhold POLYLITE Polyester resin we have achieved the most efficient, least costly method of production for our compression molded automotive fresh air ducts." This report comes from Lester F. Barnum, Vice President and Treasurer of Barnum Brothers Fibre Company, East Detroit, Mich.

"POLYLITE gives us about four times the curing speed obtained with other types of molding material. Press time with POLYLITE is only 38 to 42 seconds as compared to three minutes with other materials," continues Mr. Barnum.

As to final product, he says, "the resin exhibits exceptional impact and flexural strength as well as resistance to crazing and warping. It enables us to turn out a product that exceeds our customers' rigid specifications."

Perhaps there is a Reichhold POLYLITE Polyester resin that can help increase the efficiency of your production. Why not contact RCI and check the complete line of POLYLITE resins — not only for compression molding, but also for laminating, casting, structural layup, impregnating, encapsulating, rigid polyurethane foam production, surface coating, corrugated and flat sheet production and matched die molding.

*Creative Chemistry*
*...Your Partner in Progress*

RCI

**REICHHOLD**

**REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N. Y.**

Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol • Hydrochloric Acid • Formaldehyde • Glycerine
Phthalic Anhydride • Maleic Anhydride • Sebacic Acid • Ortho-Phenylphenol • Sodium Sulfite • Pentaerythritol
Pentachlorophenol • Sodium Pentachlorophenate • Sulfuric Acid • Methanol

# *Achievement awards in plastics technology*

**are established by PLASTICS TECHNOLOGY—**
**The Magazine of Applied Engineering**

*. . . for accomplishments in the calendar years of 1958-1959.*

**PURPOSE:**

*. . . of these awards is to stimulate, encourage and duly publicize new techniques in plastics processing and fabricating that can lead to new advances in technology for the future cooperative growth of the plastics industry.*

**NATURE OF AWARDS:**

*There are two classes of awards:*

**CLASS 1.** *New Developments in Plastics Processing. To an individual or a firm for a major contribution in the processing of plastics. This includes all methods whereby a plastic material, as furnished by the supplier, is molded, extruded, calendered, formed, or otherwise shaped into a finished or semi-finished part.*

**CLASS 2.** *New Developments in Plastics Fabricating. To an individual or a firm for a major contribution in the fabricating of plastics. This includes all operations such as decorating, bonding, assembly, or others whereby a semi-finished part is transformed into a finished, saleable product.*

**ENTRIES:**

*Entries may be submitted by any interested person or firm before the closing date, December 31, 1959, using this entry form. All entries should be submitted to: Executive Secretary, Achievement Awards in Plastics Technology, c/o PLASTICS TECHNOLOGY Magazine, 630 Third Avenue, New York 17, N.Y.*

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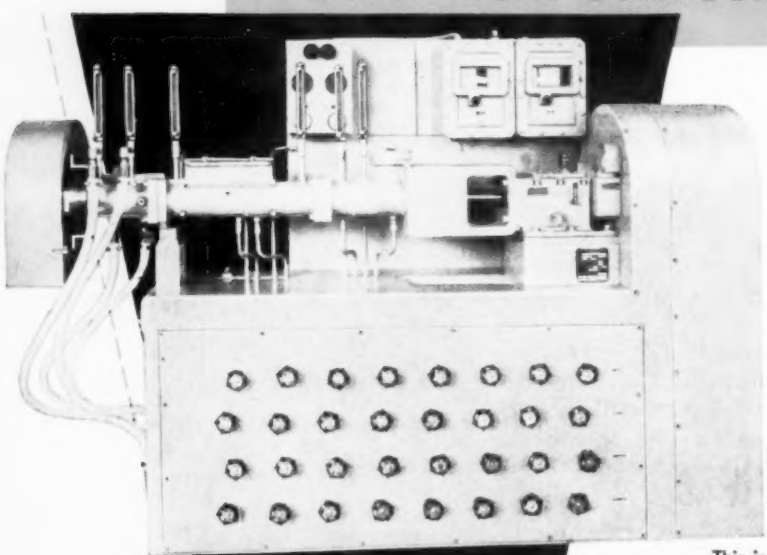

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PLASTICS
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# Measuring Resilience of Flexible Urethane Foams

**Static and dynamic test methods are discussed, and a simple, accurate apparatus described for the latter method.**

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PAUL HERSCH, *Physicist*,
G. G. STIER, *V-P in Charge*,
*and*
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*Plastics Division, Nopco Chemical Co.*
*North Arlington, N. J.*

IT is currently possible to produce polyurethane foams for a wide range of applications. The more-resilient types (those described as having snap) are used as comfort-cushioning materials, while the less-resilient types (energy absorbing) are used as package-cushioning materials. Because of this potentially broad-resilience spectrum, a definite need exists for a reliable quantative test method to evaluate this property. Largely due to the interest shown by the furniture industry, the plastics industry (through the SPI Urethane Foam Test Methods Subcommittee) has been investigating a number of methods for measuring resilience.

In addition to cooperating with this group, Nopco independently has sought to achieve greater understanding of this physical property. Two loading rates have been selected to evaluate it; a relatively slow (approaching "static" conditions), and a rapid flexing (dynamic impact). A correlation of results from the two methods was to be expected. However, for the dynamic test in air, this correlation did not materialize (see Figure 1). Further supposition suggested performing the dynamic test in a vacuum, thereby eliminating the effects of air. Figure 2 indicates that, in fact, there is a correlation between foam resiliences (neglecting air effects) at both "static" and "dynamic" loading rates.

This paper describes the particular "static" and "dynamic" tests selected, the reasons for such a choice, and the results obtained. It is hoped that this information will be of value to the plastics industry in selecting a suitable resilience test or tests. And, that such tests will contribute towards the design of the proper plastics' foam structures for the various applications.

Resilience is defined as the ratio of the energy returned by a mechanical system to the energy put into that system. It may be expressed as:

$$\% \text{ Resilience} = \frac{\text{Energy returned}}{\text{Energy Imparted}} \times 100$$

There are basically two types of tests by which this can be measured; static, and dynamic. Although these tests may take many forms, an essential difference is the rate of loading. Of the several tests available*, two tests have been chosen to illustrate these conditions. These are the Compression (Static) Load-Deflection Test, and the Vertical Ball Rebound Test.

* A listing of tests to measure resilience includes: (1). ASTM D1054-55 Impact Resilience and Penetration of Rubber by the (Goodyear Healey) Rebound Pendulum; (2). ASTM D945-55 Mechanical Properties of Elastomeric Vulcanizates Under Compressive or Shear Strains by the (Yerzley) Mechanical Oscillograph; (3). Compression load-deflection (discussed in this article); (4). Vertical Ball Rebound (discussed in this article); (5). Horizontal Ball Rebound (Hocks Elasticity Tester); and (6). Single and Double Pendulum Rebound (Shopper).

Robert E. Jones was born in Madison, Wis., in 1926. He attended the University of Wisconsin, receiving a B.S. in Mathematics and Physics in 1949, and an M.S. in Physics in 1950. He joined the Forest Products Laboratory (of the Government) in 1952, and was employed there until 1955 when he went to Nopco Chemical Co. He is currently Head of the Physics Laboratory, for the firm's Plastics Division. He is a member of A.S.T.M. and, with his co-authors, a member of SPI. Mr. & Mrs. Jones have two children and live in Whippany, N. J.

George G. Stier was born in Kearny, N. J., in 1915. He has been with Nopco since 1932, where he served originally in the chemistry laboratory; became Asst. Sales Mgr. in 1937; Sales Mgr. of the Specialties Division in 1939; was promoted to Asst. Vice Pres. in 1953; and, in 1955, was named to his current position as Vice Pres. of the Plastics Division. Mr. & Mrs. Stier and their two children make their home in Short Hills, N. J.

Paul Hersch was born in New York City in 1930, and attended McGill University, Brooklyn Polytechnic Institute, and Stevens Institute, graduating in 1952 with a B.S. degree. From 1953-57, he was employed by Wright Research Div., Curtiss as Senior Test Engineer. He came with Nopco in 1957 in his current capacity as Physicist. Mr. & Mrs. Hersch have one child, and reside in Englewood, N. J.

Bernard A. Dombrow was born in New York City in 1908. He received a B.S. from C.C.N.Y. in 1929, and then attended Columbia University where he was awarded an M.A. in 1939, and a Ph.D. in 1944. He has been with Nopco since 1929 in various positions, mainly research, and has been in his current position as Director of Laboratories, Plastics Division, since 1953. His professional memberships include A.C.S., S.P.E., Sigma Xi, and Phi Lambda Upsilon. Dr. & Mrs. Dombrow have two children, and live in Teaneck, N. J.


## Static Measurement

A static measure of resilience is obtained from a load-deflection test. This test involves compressing a flexible foam specimen to 75% strain, and subsequently relaxing it. Compressing and relaxing are done at the relatively "static" rate of two inches per minute per inch of specimen height. A record is made of the stress strain relation for the loading and unloading curves. These data are illustrated in Figure 3 for a typical two pounds/cubic foot adipic acid polyester and polyether urethane foam.

From a structural point of view, the polymer molecules of a stressed foam will redeploy gradually so as to relax; a phenomenon referred to as "creep." Eventually, however, if permitted, the polymer will reorient to its original matrix. If the polymer molecules can reform instantaneously when the foam is unloaded, the loading and unloading curves will coincide. Less rapid reformation will result in greater departure between the two curves.

Static resilience, therefore, is a measure of the rapidity with which a polymer reassumes its initial structural state (initial load bearing characteristics). Alternately, the degree to which the loading and unloading curves coincide is a measure of static resilience. Since energy, is the integral of the stress-strain curve, the compression or "static" resilience of the foam is:

$$\% \text{ Compression Resilience} = \frac{\text{Area under unloading curve}}{\text{Area under loading curve}} \times 100$$

In Figure 3, note the large difference between the recoverable loading curve and unloading curve for the polyester foam, as compared to the polyether foam. The static resiliences are about 40% and 60%, respectively. An initial recoverable loading curve (defined as the load characteristic after a reasonable recovery time following straining) is obtained, and is used to compute static resilience. This "reasonable time" varies for different foams from several minutes to 24 hours, but is independent of prior flexing for a given foam.

Because the mechanism of "static" resilience is dependent upon polymer creep, it may be represented alternately as a function of this parameter. Such data can be obtained by compressing a specimen (at two inches per minute per inch of height) to a specific strain, and retaining that strain for one minute. As the polymer relaxes, the reacting stress will diminish to some lower value. In Figure 3, for example, the load was allowed to change at three discrete strains; 25, 50 and 75%. This creep represents the "fall through" or sinking feeling when sitting on a cushion exhibiting a low "static" resilience.

Rather than specify this relaxation rate at many strains, the compression resilience is used to give a continuous measure of this property to 75% deflection. However, the stress values after one minute creep for several discrete strains should be reported, since they represent the truer load-supporting characteristics of the foam where most of the creep takes place in the first minute.

## Dynamic Measurement

A dynamic measure of resilience is obtained from a ball-drop test. Essentially, this test is not new, having been employed with any number of elaborations and or modifications. Basically, it consists of a steel ball, a test specimen, and a scale to measure drop height and rebound. Since the energy imparted to a specimen struck by a falling object is proportional to the drop height of the object, and the energy retruned by the foam is equally proportional to the rebound height, the ball drop dynamic resilience is:

$$\% \text{ Ball Drop Resilience} = \frac{\text{Rebound Height}}{\text{Drop Height}} \times 100$$

A photograph of the original ball-drop apparatus used is shown in Figure 4. Although, the apparatus is similar to others, one important innovation was the use of a hollow acrylic tube, through which the ball would pass, with lines circumscribed on it at one-inch intervals. This minimized the problem of parallax error; with the proper sighting level achieved, the ball could be aligned accurately with the scale at the maximum

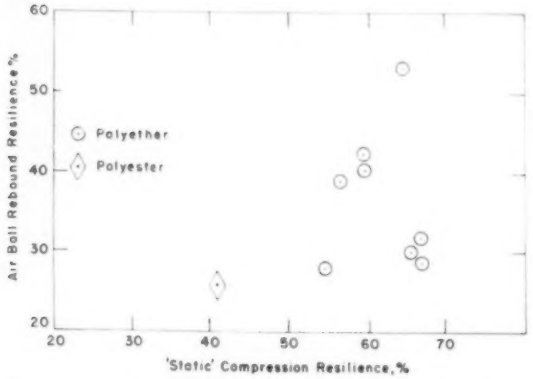


Fig. 1. Non-relevancy between "static" compression resilience and air ball-drop resilience for polyurethane foams.

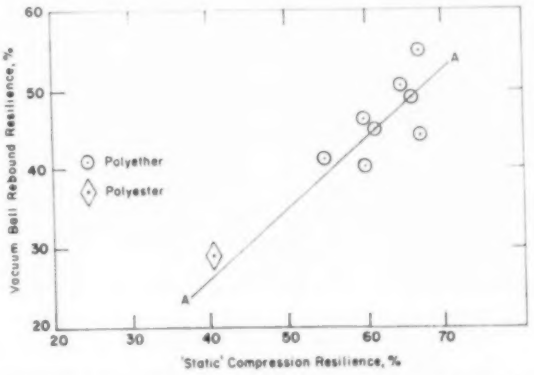


Fig. 2. Relation between vacuum ball-drop resilience and "static" compression resilience for polyurethane foams.

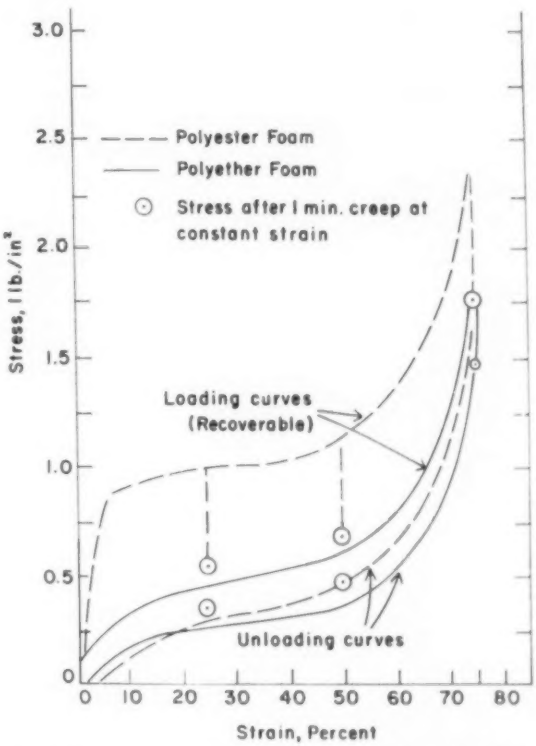


Fig. 3. Stress-strain data for a two pounds/cubic foot flexible urethane foam, showing both loading and unloading curves.

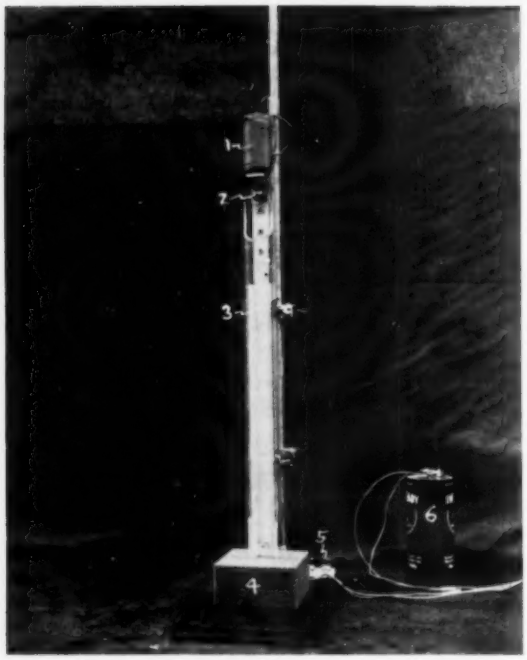


**Fig. 4. Air ball-drop test apparatus. Legend: 1—Electromagnet; 2—⅝-inch diameter steel ball; 3—Circumscribed and calibrated acrylic tube; 4—Four by four by two-inch specimen; 5—Switch; and 6—Battery.**

rebound. Using this sytem, the rebound can be measured within ±1% absolute.

The standard conditions established after a study of test variables were, as follows:

(1). A 16- or 18-inch drop. This permits an accuracy of ±1% absolute, which is considered adequate in the range of interest (30%—60% resilience). A 16-inch drop represents an initial impact velocity of 6,600 inches per minute (as compared to two inches per minute for the "static" test).

(2). A ⅝-inch diameter steel ball. This was the ball that yielded the proper threshold of pneumatic effects (as explained later).

(3). A four x four x two-inch thick specimen size. This size was picked because it was the smallest convenient size that afforded results closely approximating those for larger slabs. The standard ball bottomed too easily on a one-inch thick specimen for very soft foams.

(4). A series of three drops was made on each specimen to get an average rebound value. A minimum waiting period of one minute was allowed between each drop for specimen recovery.

Following this preliminary investigation for standardization of the apparatus, tests were performed on various experimental foams. Of special interest was dynamic resilience of low-density polyether foam, since certain industries desired a "live" foam. During the course of data compilation, certain contradictions were noted. That is, foams of equal static resiliences had radically different ball rebounds. Foams that were expected to have a 50% rebound, yielded only 30% in some instances. These same foams tended to "breathe" hard when flexed.

Prior experience had revealed disparate results between static and dynamic data for dynamic tests of foam package-cushioning materials. This discrepancy was influenced by the size and shape of the cushion. Therefore, reason dictated that the air entrained in the foam must be a responsible factor.

## Vacuum Ball Drop Apparatus

To determine the validity of this theory, an apparatus was constructed which could be used to measure the dynamic resilience in a vacuum. A photograph of the vacuum ball-drop apparatus is shown in Figure 5. The maximum rebound is observed in the same way as for the air ball-drop apparatus (see Figure 4). The ball is returned to the magnet under a vacuum of three millimeters of mercury, maximum, pressure by inverting the bell jar, (facilitated by a pair of hinges attached to the base plate) so that the ball rolls along the jar into contact with the magnet.

Data obtained from the vacuum ball-drop apparatus showed, as predicted, that some foams were pneumatic to a considerable extent. Much of the data, previously inconsistent, fell into a logical pattern. Some typical dynamic resilience data for two polyether foams, one pneumatic, and one not, are shown in Figure 6 for a series of ball weights. These data illustrate the following points:

(1). The ball-drop resilience falls off with higher ball weights for all foams.

(2). The ball-drop resilience in air of "pneumatic" foams falls off faster than their resilience in vacuum. This means that the threshold of pneumaticity can be influenced by the ball weight. That is, foams which are not appreciably pneumatic for a ¼-inch diameter ball, may be pneumatic for a ⅝-inch diameter ball. The ⅝-inch diameter ball was standardized for this reason as creating the proper threshold of pneumaticity for polyether foams currently in vogue.

## Discussion of Methods

### Comparison of Static and Dynamic Resilience Values

From purely theoretical considerations, it can be shown that a foam's resilience, neglecting air damping, is related to the rate of strain. (A brief explanation is given in the next section). In Figure 2, line AA represents a "best-fit line" based on the theory that a constant difference exists between static and dynamic resiliences for materials of similar polymeric construction.

This correlation between vacuum ball-drop and "static" resilience may or may not be apparent when the dynamic test is performed in air. Comparing Figure 2 with Figure 1, it is seen that some materials were not pneumatic, while others were.

### Mechanism of Pneumatic Damping

To understand better pneumaticity in foams, consider the "cellular" structure of flexible urethane foam. This structure is comprised of a random lattice or skeleton with thin membranes or diaphrams dispersed throughout this lattice. In general, the cell structure for flexible foams is nearly 100% open, as measured by an air-displacement apparatus. Nevertheless, pneuma-

ticity may occur for several reasons.

To have pneumatic damping, significant amounts of energy must be used in moving the air through the cellular structure. If there are a sufficient number of diaphrams, their impedance of the air flow may be significant. In some instances, the diaphrams are only partially ruptured, again yielding a foam which "breathes" hard. Finally, if the foam lattice is very fine, pneumaticity may exist without diaphrams due to the viscous flow of air through the fine lattice. Conditions leading to pneumaticity, as measured by the ball-drop test described herein, have been found most commonly in low-density (two pounds/cubic foot or less), relatively-soft foams.

### Mechanism of Polymeric Creep

Creep has been described previously as an energy loss, and several methods have been discussed for measuring this loss on a relative basis (but only by keeping certain parameters constant). There are many factors affecting polymer creep, and some of these will be discussed briefly to provide a better understanding of the tests which measure it.

The faster the polymer creep or the longer the creep period, the greater the energy loss (this being inversely proportional to the molecular chain-number and bond strength). It follows directly that the rate of "static" loading will have an effect on the resiliency. If a foam is strained rapidly, there is less allotted creep time than for a foam that is strained slowly. If a foam is strained at an infinitely slow rate, no stress will develop since the chains will relax as they are strained. Since there can be no further creep loss, the unloading curve will be identical to the loading curve.

If a foam is flexed at an infinitely rapid rate, there can be no time for creep, and again the loading and unloading curves should coincide. However, there is in addition, a thermodynamic influence, and, the second law of thermodynamics states that the recoverable energy from a full cycle process is inversely proportional to the energy application rate.

It also follows from the phenomenon of polymer stress-relaxation that the apparent foam resilience should be dependent on the severity of the strain. That is, the greater the stress, the greater the strain, the greater the quantity of stressed chains, and, consequently, the greater the creep. A flexible foam compressed 25% will creep less absolutely than if compressed 50%, all other conditions being equal.

## Conclusions

From the foregoing discussion, it is evident that to determine completely the loading behavior of a foam, it is necessary to subject the sample to both static and dynamic tests. The static test can evaluate the foam polymer, since it is applicable to comfort cushioning after the initial settling. The dynamic test can measure the polymer behavior under an accelerated load. This test also measures the foam's pneumatic damping characteristics which describe, in part, the "feel" of the foam when rapidly flexed.

By performing such a dynamic test both in and out of a vacuum, the pneumatic effect may be disassociated from the dynamic polymer resilience. For materials of similar polymeric construction, a linear relation exists between static polymer resilience and dynamic polymer resilience in a vacuum.

The specific static and dynamic tests discussed are especially advantageous. The former yields what is equivalent to an over-all static resilience in the normal cushioning range. It also affords truer load supporting values. The dynamic test is simple, yet efficient. For quality control work, it is expected that only the ball-drop test need be used, without continuous recourse to repeated static resilience testing.

—THE END

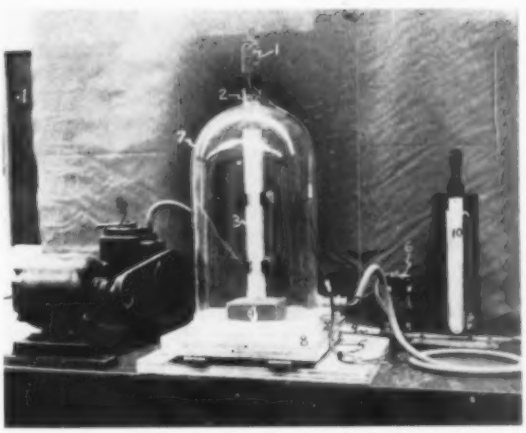

Fig. 5. Vacuum ball-drop test apparatus. Legend: 1-6—Same as for Figure 4; 7—Bell jar; 8—Inverting base plate; 9—Handle for inverting base plate; 10—Manometer; and 11—Vacuum pump.

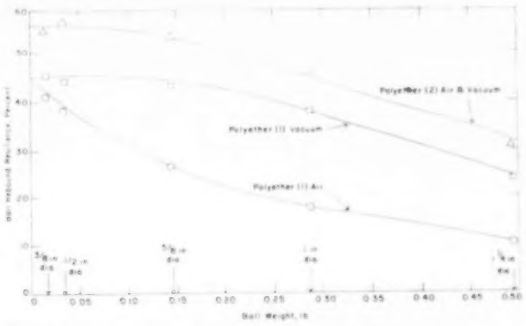

Fig. 6. Effect of pneumaticity on 18-inch ball drop test results for different ball weights and diameters.

Fiberglas-reinforced polyester sheets by Kemlite Corp. form roof of the Palm House at Chicago's Garfield Conservatory.

R. VAN CLEVE, *Leader of Plastics Evaluation Group,* (right)
*and*
R. R. COSNER, *Staff Consultant in Mechanical Engineering,* (left)
*Research Dept.,*
*Union Carbide Chemicals Co.,*
*South Charleston, W. Va.*

# Examining the Heat-Distortion Behavior of Plastics

## An improved apparatus for testing heat-distortion temperatures of plastic materials is described.

THE standard test for determining the heat-distortion temperature of plastics, as specified in ASTM Method D648-56, is one of the common screening and evaluation tests employed in the study of the mechanical behavior of molded plastics materials. This test determines the temperature at which a material will have softened sufficiently to deflect to an arbitrarily pre-selected value when subjected to a flexural stress. Testing normally is performed with a commercial testing machine designed for this specific purpose; one type is capable of testing five specimens simultaneously.

The test is begun by placing the specimens in a bath containing a heating medium, and loading the specimens as simply-supported beams by means of load rods. When the specimens are thus submerged and loaded, the temperature of the liquid bath is advanced at a constant rate. Deflection of the specimen is observed on a dial indicator attached to each loading fixture, and the temperature observed on a laboratory thermometer in the heating medium. When deflection of the specimen has reached the pre-selected value, the test operator notes the temperature of the heating medium. This temperature is defined as the heat-distortion temperature. The geometry of the molded plastics specimen, the flexure stress induced in the specimen by external loading, and the rate of temperature increase are all specified by ASTM designation D648-45T.

A number of attempts have been made by other investigators to improve the performance of the test or make test results more informative. Among these are (1). improvements in the arrangement of loading in order to minimize the effects of thermal expansion of the steel loading fixtures which might introduce errors in deflections taken from dial-indicator readings (1, 2);* (2). improvements in the method of retrieving the tested specimens from the heating medium after completion of the tests (3); (3). visually logging the deflections and temperatures at frequent intervals to give a complete deflection versus temperature relationship for more detailed study (1, 2, 4, 5); (4). redesign of the method of loading the specimen to produce a constant bending moment in the beam; and (5). complete redesign of the test to examine tensile elongation, rather than bending deflection, as a function of temperature, with the added feature of continuous automatic recording of elongation versus temperature throughout the test (6).

The Research Department of our company conducted an investigation to develop more fundamental and meaningful data by augmenting the standard procedure now produced by the ASTM test. An important requirement, however, was that modifications or additions ap-

* Numbers in parentheses refer to Bibliography at end of article.

plied to the test must not detract from the test's value as a routine screening tool, nor render the test incapable of conforming in all respects to ASTM test specifications.

The standard test as conducted in the commercially-available machine was examined critically, both experimentally and theoretically, from several view-points to determine limitations and any failures of the test to conform with the ASTM test specifications. As a result of this investigation, the following observations are of interest:

(1). The ASTM specification requires that the temperature of the heating medium be advanced at a constant rate of increase to 2.0± 0.2° C. per minute. When the temperature was monitored carefully, it was found that the rate of advance was not correct and was not constant to the tolerance required.

(2). The specified geometry of the test specimen (as a simply-supported beam) is a height equal to one-half inch and a span between supports equal to four inches. This produces a length to height ratio equal to eight. Since a length:height ratio of 10 or less is considered the value at which deflection due to shear stresses in a beam becomes important, the percentage of total deflection due to shear was calculated by the theories on strengths of materials. This value was found to be approximately 5% of the total theoretical deflection; and it was felt that this percentage was sufficiently small to accept the ASTM specification assumption that deflection is due to bending stresses alone.

(3). The temperature gradient through the specimen, as induced by the thermal conditions of the test, was examined. It was felt that if the probable gradient was large, surface indentation of the specimen might be an appreciable portion of the total apparent deflection noted by the dial indicator. Accordingly, the heat-transfer state was analyzed theoretically, based on a surface temperature increase of 2.0° C. per minute. The approximate analysis confirmed that for average materials, a steady state of heat flow is reached soon after the test is commenced, and the resulting temperature gradient from the center to the surface of the specimen is approximately 2.0°C. This gradient was considered small relative to the normal heat-distortion temperatures of most plastics materials, and negligible in the over-all effect.

(4). Investigation revealed the opportunity for a fair amount of human error in test results. Each of the five test stations on the commercial machine is equipped with a dial indicator showing specimen deflections, and a mercury switch. The mercury switch normally is set to trip at a deflection somewhat less than the specified heat-distortion value. When the mercury switch thus trips, a pilot light on the front of the machine corresponding to the particular test station goes on. As the operator notes this light, he is alerted to watch for the 0.010-inch heat-distortion deflection measured by the dial indicator, and the heat-distortion temperature is taken by means of a laboratory thermometer. Any carelessness or inattentiveness of the operator in reading the dial indicator, or reading the laboratory thermometer, can produce a serious error in the test result.

## New Apparatus

Based upon the above information, it was decided to revise the standard apparatus to improve its inherent accuracy, and yield greater information for more-rigorous fundamental studies of behavior. The following objectives were considered desirable for an improved test apparatus:

(1). The primary purpose of the test, as it now stands, is to provide an index of the deflection-temperature behavior of the material under study. This relationship is shown by a single point; the temperature at which the deflection is equal to 0.010-inch. Obviously, if the entire temperature-deflection relationship could be studied by a plotted graph, a greater amount of information could be obtained. Accordingly, the principal objective was replacement of the single-point determination with a continuous record of temperature versus deflection from the start to finish of the test. Furthermore, since heat-distortion temperature deflection is an arbitrarily-selected value, we decided to study deflections of the specimens to the maximum value allowed by clearances in the heating-medium chamber.

(2). Obviously, the testing apparatus should be equipped with an improved system of temperature control and programming of the rate of temperature increase. This was necessary to insure that the tests conformed with ASTM specifications. To monitor the tests and thus establish a level of confidence in test results, the temperature of the heating medium should be recorded continuously. This would permit immediate detection of faulty test operations.

(3). Since the test is open to human error, all practical principles of automation should be applied to increase the precision of the tests.

(4). Achievement of the above objections would entail the addition of several components to the apparatus. To increase utility of the apparatus and enhance the operator's respect for the testing equipment, components should be housed in an attractive, mobile, integrated cabinet for maximum efficiency and portability.

An over-all view of the apparatus that was assembled to implement the above objectives is shown in Figure 1. It is noted that the cabinet which houses the apparatus incorporates a cantilevered section at the top in which are mounted six strip chart recorders at eye level. Supporting this is a vertical section containing the temperature controller, a push-button control station, five aircraft-type plug connections, and five small screw adjustments. The modified testing machine is supported by a shelf, below which are located other accessory components which may be reached for maintenance by means of two hinged doors.

Six strip-chart recorders shown at the top of the photograph record all data produced by the test. The recorder at the extreme right records temperature, while the other five record deflections of the respective specimens. All are synchronous motor-driven, thus all data is plotted as temperature or deflection versus time. Since all records have the same time scale, a comparison of the temperature chart with any deflection chart reveals the complete deflection-versus-temperature relationship. The temperature sensing and recording sys-

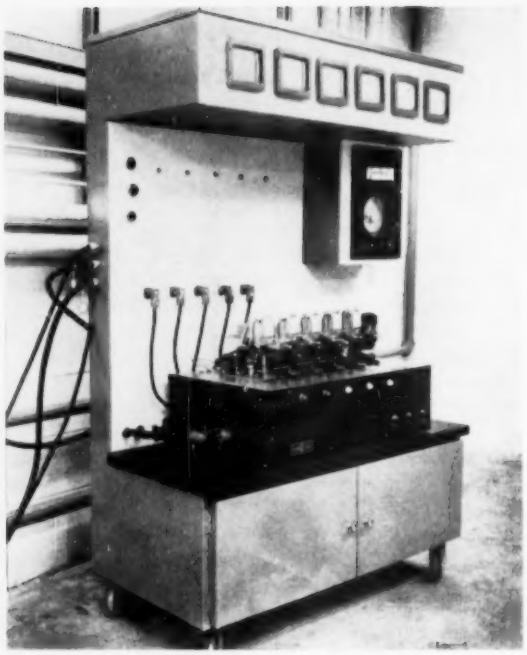

Fig. 1. Over-all view of proposed heat-distortion temperature test apparatus.

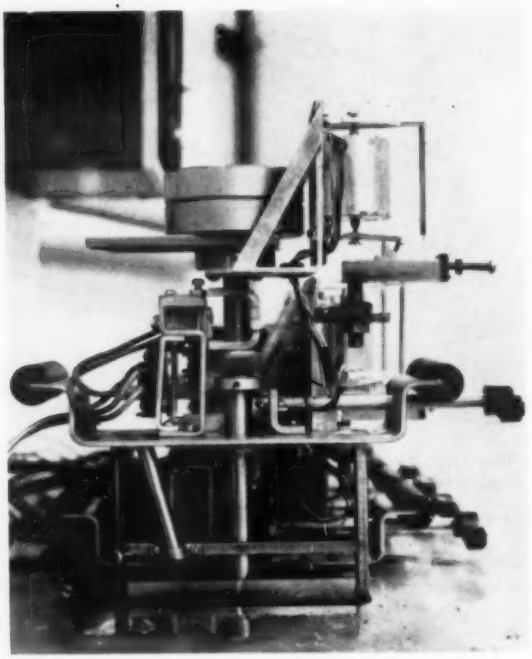

Fig. 2. Side view showing modifications made to each testing station in apparatus.

tem consists of recorder, a resistance thermometer bulb installed through the left end of the testing machine chamber containing the heating medium, and a temperature adapter which converts the signal from the resistance thermometer bulb into a signal compatible with the recorder. The complete deflection sensing and recording system will be described later in this article.

The temperature controller shown in the vertical panel of the housing is part of a complete fully-modulated system. This system consists of a separate resistance thermometer bulb, also installed in the heating medium chamber through the left end of the cabinet, a magnetic amplifier and its auxiliaries housed in the enclosed volume beneath the testing machine shelf, and the controller which is shown. The increase in the temperature of the heating medium bath is programmed by means of a precisely-cut mechanical cam installed in the controller, which advances the set-point position exactly 2.0° C. per minute. This system replaced the temperature control arrangement supplied with the commercially-available test machine.

Figure 2 indicates modifications of each testing station on the original machine. The testing station is shown in the "up" position with a specimen installed, as normally would be the case preparatory to submerging in the heating medium below. A linear-variable differential transformer assembly is shown mounted to the loading rod by means of a bracket. This device is employed to continually-sense the deflection of the specimen during the test, and transmit this deflection to the appropriate amplifier-recorder as a calibrated voltage (the voltage being proportional to the deflection of the specimen).

This is accomplished through the use of an adjustable knife-edge mounted on the frame of the testing station. This knife edge, capable of both vertical and horizontal adjustment to allow initial calibration, impinges against one of a pair of arms which support the moving core of the linear-variable differential transformer as assembled. The transformer consists of three windings in a coil around the moving core; a primary winding in the center, and two secondary windings at each end.

When the transformer core is at the axial center of the coil assembly, corresponding to the point of zero specimen deflection, voltage output of the secondary coils is practically zero. As the loading rod moves down with deflection of the specimen, the coil housing of the transformer moves relative to the core. This movement changes the magnetic coupling between primary and secondary windings, thus increasing output of the transformer. Within a limit specified by the manufacturer, this output is exactly linear with the relative motion between core and coil.

Since the transformer assembly is cantilevered to one side of the load rod, binding of the load rod in the bushed holes might be expected. At each test station, therefore, one of the three original weights supplied with the machine to load the specimen in bending was removed and replaced by a new cantilevered weight which compensated for the weight and location of the transformer assembly. This addition of the automatic deflection sensing apparatus has in no way impaired the functional operation of the testing stations nor impeded installation of the specimens.

Between the transformer and recorder in the deflection sensing and recording circuits are located capacitance-resistance adjustments which correct for any phase mismatch of calibrated voltage output of the transformer and line voltage supplied to the recorder. Five small screw adjustments on the vertical panel of

the housing provide for this correction.

When data collection functions for temperature and deflection were performed automatically by means of the sensing and recording instruments described above, the possibility for fully-automatic testing operation presented itself. This was further aided by the fact that each of the five testing stations on the commercial machine already was equipped with a mercury switch for indicating a deflection approaching the heat-distortion value. While these switches normally are set for that deflection, there was sufficient flexibility of adjustment to permit them to be set to trip at a much greater value.

Examination of floor clearance below the specimen supports in the heating-medium chamber showed that a maximum deflection of 0.125-inch was possible. Arbitrarily, a deflection range of from 0 to approximately 0.100-inch was chosen to embrace the bending behavior that would be of interest. Accordingly, all five mercury switches were set to trip at this deflection. The switches then were wired together in parallel, and this parallel-switch arrangement was wired in series with the coil circuit of an across-the-line motor starter added to the apparatus and housed in the rear of the vertical panel. The motor starter contacts were wired in series with all instrument and heating circuits in the equipment system.

When all five mercury switches were tripped, the contactor-coil circuit would open, and the other electrical circuits in the equipment system also would open. Thus, the testing apparatus would shut itself off automatically upon completion of the testing of all five specimens. To start the test, a standard on-off push-button station with a pilot light also was installed in the motor-starter coil circuit.

Operationally, when the operator desires to test for the heat distortion behavior of five specimens, he loads each of the five testing stations, submerges the specimens in the heating medium bath, and presses the "start" push-button. After this "start" button is pressed, he can leave. At some future convenient time, the operator returns to the test apparatus, retrieves the test specimens, tears off the six strip charts, and re-sets the temperature-controller programming cam. He then is prepared to again test five specimens. The six strip charts comprising the data from the test are available for detailed analysis and permanent file.

Representative test data are shown in Figure 3. This figure shows the deflection-time relationships of two super-imposed tests of three commercially-available Bakelite resins. Since the temperature and deflection records both are related to the same time scale, visual inspection and comparison will yield the quantitative temperature versus deflection relationship.

Sections A, B, and C in Figure 3 indicate the deflection-time relationships for annealed and unannealed VYHH, polystyrene, and C-11 resins, respectively. It is noted that annealing before testing has a marked effect upon the heat-distortion behavior of resins, compared with the behavior when tested in the as-molded state. It is noted further that the heat-distortion temperatures of all three resins were increased by annealing, and that the temperatures at which the materials reached the 0.010-inch deflection coincided with the generally-accepted heat-distortion temperatures as determined by the standard test machine.

## Advantages of Apparatus

The apparatus herein described has been in regular operation in our Research Department for more than one year. During this time there has been a study of data produced by the new apparatus. While there is still much to learn, certain conclusions concerning the temperature versus deflection behavior of molded plastics materials have already been reached. Among these are the following:

(1). The heat-distortion temperature of the specimen, as defined by the ASTM test specifications, may be obtained readily from the data produced by the improved apparatus. This practice is being continued to maintain evaluation compatibility with the rest of the plastics industry.

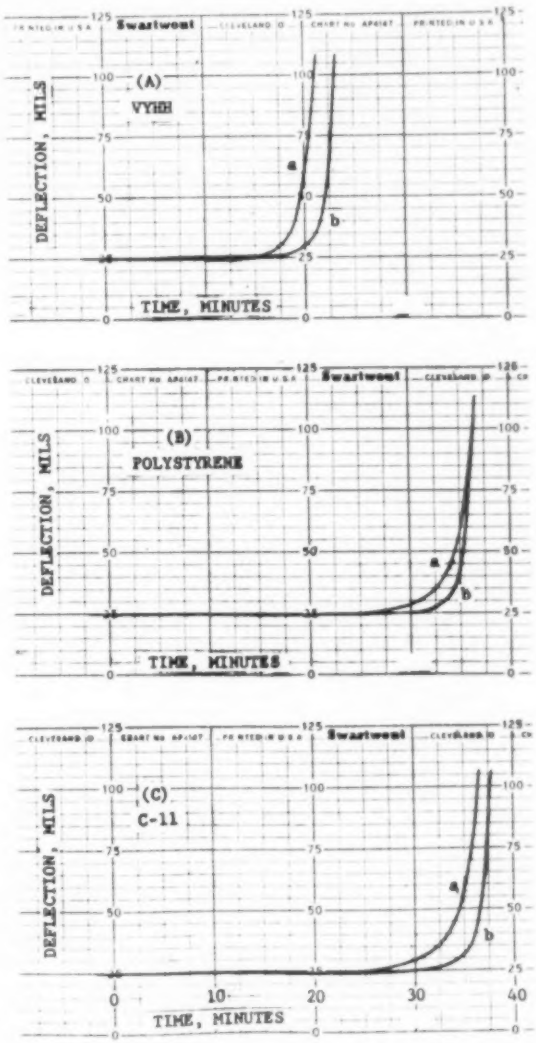


Fig. 3. Typical deflection vs. time curves obtained for three plastic materials, both (a) unannealed and (b) annealed.

(2). In addition to the heat-distortion temperature, however, the slope of the deflection versus time curve also would appear to be of interest. Since the slope of the curve would indicate the rate of change of deflection with respect to time or temperature, an index of the degree of severity of failure at the heat-distortion point would be obtained. Both the temperature and slope of the curve at the heat distortion deflection would probably present better characterization, based on a single point determination, than the heat distortion temperature alone.

(3). Similarly, a second arbitrarily-pre-selected point of deflection (such as 0.050-inch) might be chosen to amplify information gained from the single-point determination of the test. Possibly the temperature at which this second deflection is reached should be noted and an index of useful behavior, in terms of the percentage ratio of the two temperatures, could be determined.

The above have been suggested as index numbers of heat-distortion behavior which may be derived from the improved test apparatus for use in routine screening and evaluation. However, the test has proven to be of considerably grea'er value in the detailed study program employed in the development of new or improved resins.

As previously stated, the apparatus herein described has been employed for conducting studies of the heat-distortion behavior of plastics materials for more than one year. Components applied as auxiliaries to the original machine have proved both rugged and dependable, with little or no maintenance required. Regular semi-skilled laboratory personnel have been entirely capable of not only the operation of all aspects of the test, but also the periodic routine re-calibration that such equipment normally requires. Data charts have been easily filed for future reference, and have proved to be of value in detecting changes in compounding or molding techniques.

## Acknowledgments

The authors wish to acknowledge the technical assistance rendered by the sales engineers representing the Swartwout Company and the West Instrument Company. They further wish to acknowledge the efforts of H. H. Hart and C. T. Barker for their technical contributions to the design and development of the test apparatus described.

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—THE END

# Plastic Books Roundtrip Passage

A short trip to Italy is scheduled for some American-made plastic. The Fiat 2100, soon to be sold in this country, sports 12 pounds of Kralastic, a resin-rubber blend produced by U.S. Rubber Co.'s Naugatuck Chemical division.

The five-passenger, six-cylinder 2100, latest member of this Italian automobile line, has windshield and window trim, steering wheel housing, and dashboard injection molded from Kralastic in Italy.

The dashboard, which was displayed at a regional SPE meeting in Detroit last June, is formed in one piece by Cigala and Bertinetti, Turin. The largest plastic piece in the car, it is four feet long and a foot wide. Its black, dull-textured surface minimizes glare. Also molding car parts are Cavis and Stars, Fiat subsidiaries in Turin.

According to Naugatuck, the plastic is being used because it has good impact and stress resistance, adequate heat resistance, and is dimensionally stable and lightweight. Its use eliminates considerable trim and painting.

Each Fiat 2100 to be exported to the U. S. shortly, contains 12 pounds of Kralastic, injection-molded in Italy. Included are dashboard, window trim, and steering wheel housing.

*Guest Editorial*

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# Unfair Competition

EVERY injection molder would do well to study the two authorities on Unfair Competion*, and to reshape his thinking about how to protect himself from the unscrupulous copier.

All competition, by its very nature, is unfair because someone always loses the order. While the anti-trust laws say, in effect, that you cannot try to establish a dominant trade position simply by absorbing your competitors, nevertheless the basic idea behind them is to stimulate the growth of our economy by promoting healthy competition. It is therefore no anomaly that the courts have been slow to define just what constitutes "fair" or "unfair" competition, or otherwise to try and reshape business morals and practices.

This specific field of law is a relatively new one. Unfair competition is still a highly-nebulous legal area, not too clearly defined. It borders on trademarks and patents, yet is not too closely related to either. This is just another way of saying that it can be highly dangerous to institute an unfair competition suit; since little precedent exists, reversals are likely, and little or nothing can be accomplished in the way of protection or indemnity. The suit will be far more costly than those in which specific issues pertaining to actual patents and trade marks can be joined, and the chances of recovery would seem to be relatively small unless there has been conjoint violation of the anti-trust laws which do appear to have teeth in them.

Judging from past cases, the courts are not anxious to spell out for the business man the nature and details of the moral practices that govern everyday business transactions. The vast differences in the mores of different industries alone show how wise the courts have been to avoid being made into punitive tools whereby one business man can harass another simply to try and limit a competitor's growth. To anyone reviewing the cases cited in the authorities, and especially in the supplements thereto, it is rather surprising to see the growing number of injection molding concerns involved in efforts to protect themselves from copiers.

One highly significant growth factor in the relatively-new injection molding industry, as it pertains both to molding and equipment, has been the frequent establishment of new businesses and new product lines through the appearance of copies. Little or no product protection appears to be available against such copying that will stand up in court. How, therefore, does the molder or equipment maker protect himself against unscrupulous pirating of his products and ideas?

From the paucity of cases in which the entrepreneur has been able to secure a legal decision in his favor, it is apparent that the courts will take little if any interest in protecting someone against the copier, even in the case of the so-called "Chinese Copy" of an article, or of lifting of advertising even where copyrights have been obtained. Where no patents are involved and only a moral issue is at stake, unless the anti-trust laws can be invoked, the molder or equipment maker has only two recourses. The first is suggested by the authorities cited, and the second is a corollary developed by the writer.

The best protection possible against unscrupulous copiers is to maintain one's trade-secrets and know-how intact. Bona-fide secrecy seems to be the only and best real protection against concerns that would like to ride free on another's coat-tails. And to get protection from the courts, real secrecy must be maintained! There is only one conclusion, and it is such a sharp reversal of our usual trade policies that one can easily anticipate the repercussions of this suggestion: "The time is

* "The Law of Unfair Competition and Trademarks," by Harry D. Nims, 2 vols. Baker, Voorhis Co., New York, N. Y. (1947).
"The Law of Unfair Competition and Trademarks," by Rudolf Callmann, 5 vols. Callaghan & Co., Chicago, Ill. (1950, 1951, 1959).

ripe to close up the open molding shop!"

This will handicap the exchange of technical information advocated by the SPE and SPI, but it will afford the only available protection against copying. In many cases copies have appeared so suddenly that, unless one knew better, it might almost be assumed to be a case of parallel development. The delay- and lead-time which real secrecy can afford the entrepreneur is likely to be a far more valuable asset than a patent, particularly a design patent which seems to have little real meaning or effect. The patent field itself is so ambiguous, crowded, behind schedule, and "real novelty" is so open to question and expensive to define, that little if any protection can be looked for there, especially by the smaller business man.

There is only one real solution: be extremely careful who sees your molds and the details of your tooling, gating, venting, and molding operations. Do not reveal the results obtained with special-purpose heating cylinders, mold chillers, re-vamped water passages, or other special modifications made to items of standard equipment. Do not let people see your trimming, finishing, material handling, and other home-built or specially-made production accessories. Do not let your product designs and merchandising plans be known until your products are warehoused ready for the market. Protect your technical know-how by keeping it a secret.

The next best protection against the design pirate is not detailed in books. It is to establish an unassailable record for fair dealing and integrity. This will permit you to build up such a strong customer following that the familiar story of one product being "just like another, only cheaper" will fall apart on the basis of your product's performance and merit alone. Thus, one can justify the legitimate claim to superiority that in 99 cases out of 100 almost invariably accompanies product originality.

Customers soon learn where new developments come from, and which always mark creative thinking and denote progress. Specialists in individual fields usually are leaders, whether it be in molding pen barrels, nylon parts, or linear housewares, or whether it be in equipment limited to specific applications in a specific industry, such as mold chillers, part grinders, or heating cylinders. Copies, more often than not, lack quality because the copier lacks know-how. Copies seldom give the customer the satisfaction he needs to justify repeat orders. One molder has a sign in his shop that states that long after the sweet taste of a cut-price imitation has faded, the bitter thought of poor quality is likely to remain.

Time and healthy business operations inevitably separate the copy from the product of the pioneer, and prove the wisdom of the courts in not being easily led to adjudicate which sales were "fairly" and which were "unfairly" lost. Copiers always lack background and experience. While they temporarily or apparently may appear to profit from unethical acts, it has been very seldom that such businesses have risen to a position of trade eminence and stayed there.

The vision, ingenuity, energy, and forethought of the original developer cannot be copied. By secrecy, the entrepreneur can protect himself until his product is fully ready for the market. Then, by his integrity, he can maintain the lead that derives from his ingenuity and other attributes, while the copier is still trying to figure out cores, gating, cooling, special nozzles, special tolerances, drafts, and other specialized process adjuncts which give the pioneer the advantages needed to keep him ahead by "fair" competitive means.

A molding shop closed to all except the most trusted process consultants used to mean that its equipment was obsolescent, its methods antiquated, and that the management was ashamed of what the visitor might see. Today, it could mean just the opposite. Well-maintained secrecy might well spell the difference between the success or failure of a new product by preserving its priceless lead-time.

At no period in the brief, 20-year history of the injection molding industry have more small molders been preparing to introduce more worth-while proprietary articles. Good distribution is going to be essential, and larger firms with established outlets will have a normal edge. The smaller molder has a lot to learn about the costs and techniques of breaking into the big-volume markets now opening up in containers, spouts, closures, and other disposables, as opposed to his previous and self-limited markets for tile, housewares, and component parts where the very life and utility of the article limited its market growth. But apart from the magnitude of the sales problem, the ingenious injection molder is going to be faced with an unprecedented rise in the kind and amount of "unfair" competition as copiers try to cash in on new ideas for new products now under wide scale development. Design patents and basic patents are going to be few and far between; and even then they will be so remote, so costly to defend, and so ambiguous that formal legal protection cannot be relied on. But, while you cannot patent know-how, you can still protect it with secrecy.

Every injection molder, therefore, should study the law of trade secrets which is covered in both of the cited authorities. The manifest unfairness of most product-copy situations often is so incredible that it seems almost impossible to believe that legal redress is not available. Yet, it is a fact that little or no help can be had from the courts, except in the rare cases where the rather broad spirit of the anti-trust laws can be invoked. Secrecy and integrity, therefore, are the two chief tools with which to oppose unscrupulous imitators, and it is well worth reading the two authorities to verify this fact for oneself.

Finally, when your product is copied or your idea approximated by a ruthless imitator, do not try to beat him by reducing price, cutting wall sections, or raising mold heats past the danger point where the good properties of your plastics material are boiled off in the molding operation. Do not be led into the fatal area where by down-grading your material, lowering your quality standards, and cutting prices, you no longer have the margin needed to do the critical sales work necessary to move your product into volume markets.

Remember the great miracle that is America today —where one can specialize to the limit and still grow. Look ahead. Guard your trade secrets. Maintain your integrity. The copier will always be behind you!

—THE END

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# What a Plastics Engineer Should Look For When Planning to Buy Auxiliary Equipment for Extrusion

Advanced planning on the part of the engineer, with considerable thought devoted to what the equipment must accomplish, is needed for intelligent selection of auxiliary equipment for the extrusion plant.

AUXILIARY equipment for extrusion can be considered in two steps; i.e., certain auxiliary equipment is necessary to prepare and handle the raw material prior to and during its entrace into the extruder, and other auxiliary equipment is needed for handling the extrudate. In the first case, the same general type of auxiliary equipment can be used regardless of the end-product being fabricated. Such items as hopper loaders, hopper dryers, ovens, and heater controls can be included in this category. However, auxiliary equipment designed for handling the extrudate varies widely.

Basically, the extrusion industry can be divided into seven major segments, each segment being an industry of its own. These segments can be listed as flat sheet, pipe, extruded shapes, film, wire coating, monofilament, and blow molding. The auxiliary equipment needed for each of the above industries is completely different and must be considered individually.

When planning to purchase auxiliary equipment for an extrusion line, the engineer should consider what it is necessary for the auxiliary equipment to accomplish, and then arrive at a definite set of specifications for the equipment. Because of the wide diversity in requirements for auxiliary equipment within the extrusion industry, no one manufacturer supplies a complete line of auxiliary equipment. Thus, several firms may have to be contacted to obtain a complete line.

The costs of the various pieces of equipment will vary from manufacturer to manufacturer. The engineer should obtain three or more quotations from manufacturers of a given piece of equipment and carefully compare the specifications from these sources with his own. In general, as is the case in most purchases made today, you get what you pay for. This does not necessarily mean that the most expensive piece of equipment should always be purchased. Rather, the engineer should choose the equipment best suited for his particular operation, and consider cost as secondary

### Hopper Loaders

One of the major labor-saving devices in the extrusion plant is the hopper loader. Hopper loaders are utilized to convey the plastic granules from the container to the hopper that feeds the extruder. Hopper loaders are operated by passing compressed air through a venturi, thus creating a low-pressure area behind the venturi and drawing the granules from the floor area to the venturi. From this point, the compressed air pushes the granules through the delivery tube and into the hopper.

Hopper loaders are available in a multitude of sizes. The engineer should determine the loading needs of his operation and submit this information to the equipment supplier in order that proper quotations on size and cost may be obtained.

In addition to saving labor, the hopper loader reduces the possibility of contamination of the plastic granules prior to loading the extruder. There also is less chance of raw material spillage when using a hopper loader in lieu of a pail or scoop.

Another important consideration when purchasing a hopper loader is the provision for supplying dried air to the loader. Many plastic materials will pick up water that has a deleterious effect on the extruded part. Some loaders provide heaters for heating the air. However, it certainly is more important to have the air dry than heated, since the amount of preheating that occurs during passage of the granules through the loading pipe is negligible.

### Hoppers

The hopper of an extruder should be large enough to provide for a minimum of one hour's inventory. This is particularly important when drying of the granules is necessary. There are several varieties of hoppers on the market. Perhaps the simplest is merely a sheet metal cone which sits upon the extruder above the hopper opening. This performs the function of getting the material into the extruder, but provides no means for passing warm air through the granules to remove moisture. Hoppers are available with baffling arrangements which do allow for passing warm air through the granules.

With the trend towards higher outputs for a given size extruder, hoppers are now available which circulate the plastic granules in and out of the hopper, i.e., the plastic granules are loaded continuously to the hopper, a certain amount going into the extruder while the remainder is circulated through a container and reloaded by the hopper loader. This permits the use of higher air temperatures for drying since the material is not held in the hopper long enough for caking to occur.

Another recent development in hoppers is the vacuum hopper. In this arrangement, a vacuum is created in the hopper, thus enabling air and volatiles to be pulled out of the extruder and back out of the hopper.

The hopper dryer serves a dual purpose: (1). surface moisture which may be present on the plastic granules is removed by the heated air; and (2). to insure that the temperature of the feed to the extruder screw is constant. Plastic materials which do not absorb moisture may be dried relatively easily with the hopper dryers. However, those plastics which absorb moisture are difficult to dry and probably will have to be dried in air-circulating ovens prior to extrusion.

### Ovens

Electrically-heated ovens of the circulating-air type are perhaps the most popular in the extrusion industry. Air is circulated over the heaters to heat it, and baffles deflect the air so that it flows over the granules which are held in trays. Ovens should be large enough to hold a minimum of two hours' supply of material per machine. The granules should be placed in a tray so they are no more than one-inch deep. Occasional hand-stirring of the granules in the tray may be necessary. Vents should be provided in the oven for removal of moisture-laden air.

Very little benefit can be achieved with ovens insofar as uniform preheating of the granules is concerned. The material will lose its heat prior to extrusion. However, a combination of oven drying followed by hopper drying will eliminate this problem of non-uniform feed temperature.

### Control Panels

Some equipment manufacturers consider control panels as auxiliary equipment. Control panels contain the heater controls, screw-speed indicator, motor amperage, screw-speed controls, and starter switch. These instruments usually are mounted on a panel immediately adjacent to the extruder.

Three basic types of controllers have been used with varying degrees of success on the cylinder heaters. They are the "on-off" type, the proportioning type, and the saturable-core type. The "on-off" type controller consists of a thermostatically-controlled switch which turns the current on and off. Current to the heater is not turned off until the control point is reached, therefore some over-riding in temperature may occur. The proportioning controller adjusts the "time on" period of the heater in a cyclic manner such that input to the heater is reduced as the control point is approached. This minimizes the problem of temperature over-ride. The saturable-core controller also is of a proportioning nature, but adjusts the current to the heat input needs instead of adjusting the "time on" period.

All of these controllers have been used in successful extrusion operations. Obviously, for extremely accurate temperature control, the saturable-core type would be chosen, but would be the most costly. The engineer should determine the necessity for varying degrees of temperature control in his process, and choose the proper degree of instrumentation for his plant.

### Scrap Grinders

Grinders of varying size can be purchased to reduce extruded scrap to chips which, in turn, can be re-extruded into saleable product. It is essential, however, that the reground material be clean. To this end, it is advisable to locate the grinding facilities centrally in an enclosed, dust-free room. Careful plant layout will streamline the flow of scrap to the grinding

room and the reground material back to the extruder. Large pieces of scrap may have to be reduced in size prior to grinding by sawing.

## Take-Away Equipment

### Flat Sheet Extrusion

Auxiliary equipment necessary for the extrusion of flat sheet has been fairly well standardized. Cooling of the extruded sheet is accomplished by passing the extrudate through a three-roll stack. The rolls are 6-12 inches in diameter, and are ground to a six micro-finish prior to chrome plating. They are cored and baffled to permit circulation of a heating media, usually water.

The rolls are driven through a system of worm gears, and the speed of the rolls usually is controlled through a variable-speed drive. Speed range of the rolls should be considered carefully in the light of the flexibility that may be desired in the extrusion operation. That is, the rolls will have to be capable of turning at very slow speeds for extra-heavy gage sheet to keep sheet draw-down to a minimum, while the rolls must turn rapidly for the thinner gage sheets. The engineer should determine the range of sheet thickness he will manufacture, and specify that the roll stack function accordingly.

Roll temperatures are controlled by circulating heated water through the internal channels of the rolls. Water temperatures are maintained by immersion-type heaters that are controlled thermostatically. The quality of water used in the temperature regulators is of utmost importance. Mineral-containing water will soon cause plugging of the roll passages, making it impossible to control the roll temperatures accurately. The engineer should investigate the need for treating the water chemically to prevent plugging.

The three-roll stacks often are referred to as "polishing rolls." While it is true that the surface polish of the roll is transmitted to the surface of the plastic sheet, much of this gloss is destroyed during subsequent heat fabrication (such as vacuum forming).

SHEET GLOSSERS OR GLAZERS. Some fabricators laminate oriented films to the surface of high-impact polystyrene sheet, thus enhancing the surface of the sheet. This film can be mounted on the three-roll stack and laminated directly to the sheet during extrusion. While this technique is certain to improve the sheet's appearance, it should be recognized that physical properties of the laminated sheet are reduced as compared to those of the base sheet.

Another method of improving the appearance of the base sheet is through the use of a sheet polisher or "glazer." This equipment consists of a series of small-diameter driven rolls cored for cooling and so placed as to become a conveyor. The unit is placed between the die and the three-roll stack, the driven rolls supporting the sheet. Infra-red heaters are placed above the sheet to heat its surface prior to its entrance into the three-roll stack. High gloss is obtainable in this manner, but care should be taken to prevent overheating and subsequent property degradation of the sheet. Attention should be given to the methods for moving the heaters up and down, necessary to obtain different degrees of gloss for different materials.

The sheet is pulled from the die by rubber-covered draw rolls. In most cases, these draw rolls are driven by a variable-speed drive similar to that used on the three-roll stack. Therefore, care should be taken in selecting the draw-roll speed range so that it coincides with the speed range of the three-roll stack.

The shear which cuts the sheets to length usually is an integral part of the draw-roll unit. Shears are available which are actuated mechanically, hydraulically, or pneumatically. The sheet length is adjusted either by an electric-eye unit or by a mechanical-trip mechanism. In some cases, the guillotine shear "travels" for a short distance with the sheet prior to the cut. This allows the sheet to be cut while moving, thus eliminating any possibility of sheet stoppage at the die with subsequent gage variation. Shears are available with a wide range of stroke. When purchasing a shear, the maximum sheet thickness to be cut must be specified, since certain models currently on the market would cut ¼-⅜-inch thick sheet only with difficulty.

Often it is desirable to edge-trim the plastic sheet to achieve proper sheet width. This can be best accomplished by the use of circular cutters rotating against an arbor roll. These hardened cutters can be located between the draw rolls and the shear. The cutters are set just deep enough so as to shear almost through the sheet, the remaining few thousandths sheet thickness simply breaking through. The edge-trim is reground and put back into the extruder.

After the sheet has been trimmed and cut to length in line, sheet stackers pile the sheet on pallets for shipment or movement from the extrusion area. One arrangement involves moving belts rapidly taking the cut sheet away from the shear and depositing the sheet on a "collapsible table." When the sheet hits a stop at the end of the stacker, the top or "fingers" of the table collapse and the sheet drops down onto the pallet. Other stackers simply carry the sheet away from the shear on belts, and drop it over the end to pile up on the pallet.

### Plastic Pipe Extrusion

Auxiliary equipment needed for the extrusion of plastic pipe consists of a sizing apparatus, cooling tanks, draw rolls, coilers, and cut-off mechanisms. Several sizing techniques are used in extruding plastic pipe. Three such techniques are: (1). sizing plates; (2). external chamber (bazooka); and (3). internal mandrel.

The sizing-plate method involves supporting the extruded section by a series of cooled brass rings while spraying water uniformly on the surface of the pipe to set the section shape. This series of cooled rings is "stepped down"; i.e., the ring diameters become progressively smaller as the pipe is sized until the last ring is approximately the desired outside diameter of the pipe. The pipe is then pulled through a water bath to complete the cooling.

The external chamber or bazooka is another method used to size the external diameter of a pipe. A water-cooled metal box is mounted near the die orifice. The

inside bore of the sizing box is approximately that of the desired pipe diameter. The extruded pipe is expanded against the cooled walls of the chamber, thus setting the outer surface of the plastic. The pipe is forced against the chamber wall by blowing air through the mandrel or by reduction of pressure between the pipe and the bore of the sizing chamber. Water is circulated through the sizing die, and small holes can be drilled through the chamber walls for applying vacuum. After leaving the chamber, the pipe is pulled through a long water bath to complete the cooling.

A third method of sizing pipe is called the internal-mandrel technique. This technique differs from the two previously discussed in that the internal diameter of the pipe is sized. In this method, the mandrel of the die is extended outside the die orifice, and is cored for the admittance of cooling water. The mandrel is insulated from the rear of the die to prevent localized die chilling. The die is designed so as to give the desired wall thickness of pipe. After leaving the mandrel, the pipe is pulled through a long water bath to complete the cooling.

Cooling tanks used for pipe extrusion vary in length from 10-40 feet. They are constructed in such a manner as to allow open circulation of cooling water in and out of the tank. Some tanks allow for only the use of tap water in and out of the tank. Others provide refrigeration units with the same water being recirculated. This accomplishes a saving in water costs. The cooling tank usually is provided with legs which can be adjusted to the correct height.

Some firms believe it more advantageous to have several rather short tanks in line, rather than one long tank. The shorter tanks are easier to move from machine to machine, and also enable the operator to run different temperature water in each tank. This may be important, particularly in the case of heavy-wall pipe where more gradual cooling may be preferred.

Draw rolls or pipe "pull-offs" are located immediately after the cooling tanks, and pull the extruded pipe away from the die and through the water bath. Some draws consist of driven rubber-covered rolls which are contoured to the approximate outer diameter of the pipe. Vari-speed drives are used for adjustment of the take-away speed. Other "pull-offs" consist of three or more belts spaced uniformly around the outer diameter of the pipe. These belts ride on pulleys which are movable in and out to provide for varying pipe diameters. Take-away is accomplished by the friction between the belts and the pipe surface. When purchasing pull-off equipment, the speed range of the unit, as well as its adaptability to varying size pipes to be extruded, should be top considerations.

Certain plastic pipe materials cannot be coiled; i.e., polystyrene, rigid polyvinyl chloride, cellulosics, and other relatively stiff materials simply must be cut to length for shipment. Polyethylene pipe, however, very often is shipped as a coil, except in the larger pipe diameters. Pipe coilers consist of a large capstan (3-5 feet in diameter) that can be driven at approximately the same speed as pipe draw rolls. The end of the pipe is hooked on the capstan and the pipe is wound up, layer upon layer. The coiler is so constructed that when the pipe coil is complete, it readily can be slipped off the capstan drum for packaging. As in the case of pull-off equipment, the coiler speed range should be wide enough to accomplish the needs of the extrusion plant.

A wide variation of cut-off equipment is used in the plastic pipe industry. Perhaps the simplest item is an ordinary hacksaw. Since this method requires the attention of an operator, most firms use power saws which can be set up to operate automatically. Some saws are designed to "travel" at the same rate as the extrudate, thus assuring no hold-up of the extrudate at the die, with subsequent sizing difficulties.

### Extruded Shapes

Auxiliary equipment used in the shape-extrusion industry is built, to a great extent, by the individual extruder himself (or at least designed by him). This is almost a necessity because of the complexity of jobs done in this industry. Sizing jigs or fingers of copper or brass are fabricated for each job by trial-and-error methods. Cooling is accomplished either by immersion or spraying with water or by air jets, depending on the nature of the plastic material. Take-away is similar to that used for pipe, except that the rolls may be contoured to resemble more closely the shape being extruded. Traveling saws are used to accomplish the cut-off.

### Film Extrusion

TUBULAR FILM. Standard equipment is available commercially for the extrusion of film by the tubular or "bubble" process. The take-off equipment can be purchased as a unit consisting of diverging rolls, and wind-up rolls. The process is such that the extruded tube is threaded through the powered draw rolls and air is introduced into the tube through the die mandrel. Enough air is introduced into the tubing to allow it to expand to the desired diameter. The air then is shut off, leaving a constant volume of trapped air between the die and the rubber-covered draw rolls. Film thickness is controlled by adjusting the speed of the draw rolls and the output of the extruder.

Prior to its entry into the nip of the draw rolls, the bubble is collapsed by a series of diverging rollers. Gusseting plates can be inserted against the bubble just prior to entrance into the draw rolls to produce gusseted bag stock. The flattened film then is wound on a variable-speed, powered film wind-up roll.

In some cases, such as when extruding polyethylene film, it is necessary to treat the surface of the film prior to printing or decorating. In some cases, the electronic treater is placed between the draw rolls so that the film is treated as it is extruded. This saves rehandling the film for treatment in a separate operation.

FLAT FILM. The extrusion of flat film can be accomplished by using either a water-bath cooling technique or the chilled-roll casting technique. In the water-bath method, the extruded film is stretched to the desired thickness between the die lips and the water bath. The water bath is constructed to permit circulation of cooling water, and built so that it can be raised up to within an inch of the die lips. A weir is used to

maintain the water at the desired level. Since accurate water-temperature control is necessary for good results, the cooling water usually is passed through a recirculating-type controller.

The take-off unit for flat film consists of a pair of squeeze rolls immediately after the water bath to take the film away, as well as to squegee-off excess water carried from the water bath by the film. Film then is pulled over idler rolls by driven rubber-covered draw rolls, and is wound on a turret-type winder. In flat-film extrusion, a slight bead usually forms on the edge of the film, and is trimmed off by razor slitters prior to winding the film.

The chilled-roll casting technique consists of extruding the film directly downward onto a chilled drum 10-24 inches in diameter. The drum is cooled by internally-circulating temperature-controlled water. Extruded film is wrapped around one or more such drums prior to entry into the take-off system discussed above. The rolls have a highly polished, chromed surface which imparts good gloss to the extruded film. Higher production speeds are claimed for the chilled-roll technique versus water-bath method due primarily to elimination of the water "carry-over" problem prevalent in the latter.

### Plastic Monofilament

Plastic monofilament has found wide usage in applications such as upholstery fabrics, ropes, bristles, outdoor furniture tapes, etc. Auxiliary equipment for the extrusion of plastic monofilament differs somewhat, depending on the plastic material being extruded. In general, however, the equipment consists of a controlled-temperature liquid bath; snubbing and orienting rolls; spooling equipment; and scrap roll.

Depending on the polymer being extruded, the water-bath temperature must be varied; i.e., the bath temperature for saran might be 10-15° C., while the bath temperature for linear polyethylene would be 85-100° C. The cooling or quench tanks are equipped with circulating pumps, and have refrigeration or heating methods that are controlled thermostatically. The plastic monofilaments are extruded downward into the quench tank, and are held immersed by rollers or shoes.

Take-off is accomplished by wrapping the band of unoriented filaments around a pair of snubbing rolls. This equipment consists of a pair of rolls mounted one above the other with perhaps 8-10 inches spacing between the centers. The rolls are positively driven at the same speed, and the speed range is controllable through rheostats. Depending upon the plastic material being extruded, the snubbing rolls may need provision for internal heating so that the plastic filaments may be maintained at the proper temperature prior to orienting. The most common method of heating employs internal steam heat which must be controlled accurately.

The orienting rolls usually are attached to the same base unit as the snubbing rolls. This set of rolls is identical in size and spacing to the snubbing rolls, and should be capable of traveling at speeds up to 10 times faster than the snubbing rolls. The band of filaments is wrapped several times around the orienting rolls, and the speed differential between the set of snubbing rolls and the set of orienting rolls determines the degree of orientation effected in the monofilament. (This speed relationship often is called the "orientation ratio.") Equipment should be designed so that once the orientation ratio is determined, the speeds of both the snubbing and orienting rolls can be altered simultaneously, thus maintaining the same orientation ratio regardless of take-off speed.

The oriented filaments are wrapped around a scrap roller after leaving the orienting rolls. The purpose of this equipment is to take the filaments away from the orienting rolls, and keep collecting them until they can be wound individually on the spoolers; i.e., during the "threading up" period. Once the filaments have been separated and placed on individual spools, the scrap roll is used only intermittently to pick up thread breaks. The scrap roll usually is nothing more than a driven revolving drum whose rotational speed is controlled by a Variac. Speed of rotation must be such that the band of oriented filaments is taut enough to prevent sagging and entanglement into the spooling equipment.

The basic types of spooling equipment are horizontal spoolers and vertical spoolers. As the names imply, the horizontal spooler has the spool spindles located in a horizontal plane, one above the other. Perhaps as many as 48 spools are placed on the frame. The vertical spooler has the spindles located vertically in two or more rows. In the case of the horizontally-mounted spindles, all of the "threading up" operation is done from one side of the equipment. In vertically-mounted spoolers, it may be necessary to thread up from both sides of the machine.

In either case, the spool spindles are driven individually with variable-speed, constant-torque motors. As the filaments are collected on the spools, the speed of the motor is adjusted automatically so as to maintain a constant tension on the filament. A level winding mechanism, either cam-actuated or hydraulically-actuated, is an integral part of the spooler, and its function is to distribute the filament uniformly on each spool. Before the filaments are placed on the spools, they are separated by porcelain guides to keep twisting of the threads to a minimum. These guides are mounted on a bar between the orienting rolls and spooling equipment.

### Wire Coating

Auxiliary equipment needed for wire coating differs somewhat depending on the size of wire being coated, the plastic material involved, and other factors. In general, the equipment consists of a wire let-off, some means for preheating the wire, cooling tanks, pull-off capstans, festoons, and wind-up rolls.

The wire let-off is used to hold the uncoated wire prior to its entrance into the die. It consists of a frame designed to hold the coiled wire, and a brake shoe so arranged as to apply pressure on the wire spool. This maintains a tension on the wire, helping to keep it centered in the die. The wire usually is preheated by passing it through open gas flames lo-

cated between the die and the wire let-off. This preheating removes small traces of moisture from the wire which might affect the adhesion of the coating to the wire.

Long cooling tanks are located directly in front of the die, and the coated wire is pulled through the cooling water by the pull-off capstan. It is not unusual to see cooling tanks 30 feet long or even longer in the wire-coating industry. In fact, very often one wrap will be taken around the take-off capstan, and the wire then is redirected back through the water bath on its way to the wind-up. For high wire speeds, this is necessary to insure adequate cooling of the coating prior to spooling.

The take-off capstan consists of a positively-driven drum with variable speed. The coated wire is wrapped one or more times around the drum prior to being wound-up on the spools. Take-off capstans are available with varying speed ranges so the engineer must specify the speed range of direct interest to his firm when obtaining quotations on this equipment.

Wire speed in excess of 1,000 feet per minute are common in the wire-coating industry, and high-speed spooling equipment is available to wind the coated wire. Spoolers consist of a frame on which are mounted at least two variable-speed driven shafts. The wood or metal spools can be placed on these shafts, the wire attached to a spool, and the spool speed adjusted to that of the take-away capstan. When one spool is filled, the wire is transferred automatically to the second spool. A festooning arrangement just prior to the spooler provides sufficient slack to allow the transfer of wire from one spool to the other. The full spool then can be replaced by an empty one without interruption of the process.

### Blow Molding

Auxiliary equipment for blow molding plastic articles from an extruder is now available from several equipment suppliers. Prior to purchasing this equipment, the engineer must consider such things as product designs, desired production rates and conversion costs, and patent restrictions, as well as cost and design of the equipment.

There are several variations in the basic process of blow molding. Perhaps the simplest method is to extrude a tube directly downward from an extruder into a single-cavity mold. When the necessary tube length has been extruded, the mold is closed, pinching the bottom end of the tube. Air is then injected into the tube through the open end, and the tube is expanded against the walls of the mold. After cooling, the blown part is ejected from the mold and the excess material is removed from the part by trimming.

Another method used to obtain higher production rates is called the multiple-mold method. In this scheme, a manifold head is placed on the extruder which allows for two or more extrusion orifices, each valved in such a manner so as to operate in sequence. A blow mold is located below each extrusion orifice. As the tube extruded from one orifice reaches the necessary length, the mold closes and pinches the tube, air is injected and the part blown. At the same time, the air-operated valve directs the plastic flow from the extruder to another die orifice in the manifold and the process is repeated in another mold. This process permits continuous extrusion of the tube from the extruder.

Another process variation involves utilizing a single extrusion head that continuously extrudes tubing into a number of molds mounted on a rotating table located directly below the extrusion orifice. This process eliminates time lost for cooling inasmuch as while one part is cooling, another is being blown.

Hollow, enclosed articles, such as balls, can be blown by the "trapped air" process. Here, the tube is extruded, one end is pinched closed in the mold, and, after injecting air, movable plates slide across the top of the mold, thus sealing the end of the tube and trapping the air in the ball.

## Conclusions

Several components of the more important auxiliary equipment for the major segments of the extrusion industry have been discussed for the purpose of pointing out some factors the plastics engineer should consider when planning to buy the equipment. It must be emphasized that auxiliary equipment will vary even within the same segments of the extrusion industry, depending on the size and nature of the extruded part.

In some instances, the engineer may have the opportunity to inspect equipment similar to what he requires in operation in the equipment suppliers' laboratories, the plastic raw material suppliers' laboratories, or in other extrusion plants. This may give valuable leads as to what he may require, but more often than not some variation in the equipment may be needed to satisfy individual needs.

Advanced planning on the part of the engineer with considerable thought given to factors such as what the equipment must accomplish, its flexibility or versatility, maintenance, safety, and cost, will result in the intelligent selection of auxiliary equipment for the extrusion plant.

—THE END

This special section also includes the following:

**PT's Comparative Data on 1959 Extrusion Machines.**

**PT's Classified List of Auxiliary Equipment for Extrusion.**

**PT's Comparative Data on 1959 Blow Molding Machines.**

# PT's Comparative Data on 1959 Extrusion Machines

## (Based on data submitted by the machine manufacturers)

| Manufacturer* | Aetna-Standard # | | | | | Battenfeld | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Extruder size or model number | 1-1/2" | 2-1/2" | 3-1/2" | 4-1/2" | 6" | BE-20 | BE-40 | BE-60 | BE-90 | BE-120 |
| Screw: Number | One | One | One | One | One | One | One | One | One | One |
| Design type | To meet application. → | | | | | Various design and compression ratios, as required. → | | | | |
| Effective length, inches | 30 | 50 | 70 | 108 | 144 | - - | - - | - - | - - | - - |
| L/D ratio, excluding feed opening | 20:1 | 20:1 | 20:1 | 24:1 | 24:1 | 15:1 | 18:1 | 20:1 | 22:1 | 24:1 |
| Speed range, rpm. | 30-200 | 11-175 | 10-150 | 9-140 | 8-120 | 10-75 | 9-65 | 8-60 | 7-54 | 6-38 |
| Materials (base & surfacing): Screw | Alloy steel with Stellite tips on flights, or flame-hardened and chrome-plated. → | | | | | Hard chrome-plated, special steel. → | | | | |
| Cylinder | Alloy steel tubing with Xaloy or Xaloy 306 lining. → | | | | | Nitrided steel. → | | | | |
| Feed opening size, inches | 1-3/8 x 2 | 2½ x 3 | 3½ x 5 | 4-3/8 x 6½ | 6 x 9 | Same as screw diameter. → | | | | |
| Gear reduction type | Single-reduction helical | Double-reduction herringbone type. → | | | | Spur gearing. → | | | | |
| Thrust carrier: Type | Taper roller. → Radial thrust. → | | Flat thrust. → | Cylinder roller. → | | Ball thrust bearing, roller bearing for radial seating. → | | | | |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | 70,000 | 145,000 | 112,000 | 256,000 | 160,000 | 2,500# | 2,500# | 2,500# | 2,500# | 2,500# |
| Extrusion cylinder: Number of heating zones | 3 | 4# | 5# | 5# | 6# | 2;2## | 3;3## | 3;4## | 4;4## | 5;6## |
| Max. kw. demand on cylinder | 6.3 | 7.5-13 | 20-29 | 54-71 | 90-100 | 5;* | 5;* | 10;* | 20;* | 25;* |
| Lubricating system | Dip and splash. → | | | | | Oil bath. → | | | | |
| Drive motor, hp. | 7.5 | 20-40 | 50-100 | 75-150 | 125-250 | 3 | 5.5 | 10-15 | 25-34 | 75 |
| Extrusion capacity, lbs./hr., based on polyethylene (mol.wt. 20,000, melt index 4.0, sp.gr. 0.92) @ 500 ± 10° F. with output rate held to ±1%. | 70 | 200 | 400 | 800 | 1,500 | 7 | 35 | 85 | 175 | 350 |
| Approx. heat-up time, minutes, from room temp. to 500° F. (for polyethylene above) | 13 | 30 | 35 | 40 | 45 | 30 | 30 | 60 | 60 | 90 |
| Heaters: Type | Induction coils. → | | | | | Resistance heater bands. → | | | | |
| Controls | Three-position, non-proportioning, with thermocouple break protection. → | | | | | Thermostat. → | | | | |
| Special features (included as standard) | Portable. Thrust capacity up to 10,000 psi. Automatic water cooling. Screw-adjusting mechanism to vary internal pressure without stopping. Leak-proof, quick-opening, h-p head. Close temperature control up to 800° F. Base designed to accommodate coating dies. Stock-pressure gauge upstream from valve. → | | | | | Push-button screw speed change. Extruder & control panel as one integral unit. Dismantling of screw towards the rear of machine. → | | | | |
| Optional features (available at extra cost) | - - | Special carriage for retraction of extruder. Rectangular or circular feed openings. Devolatilizing. → | | | | Cored screw for fluid heating and cooling. → | | | | |
| Approx. floor space (L x W), feet | 5-2/3 x 2½ | 10x6-1/3 | 13 x 6½ | 17 x 7 | 22½ x 7 | 3 x 2½ | 4 x 2½ | 6½ x 3 | 10½ x 3-1/3 | 12½ x 4-2/3 |
| Approx. delivery time, weeks*** | Varies from 8-20 weeks. → | | | | | 6 - 8 | 6 - 8 | 10 | 12 | 20 |

# Includes one zone on head.

# Approximate.
## On extruder; on head.
* Kw. on extruder; kw. on head according to requirements.

* Complete company names and addresses are as follows:

Aetna-Standard Div., Blaw-Knox Co. Engineered and sold by Hale and Kullgren, Inc., 613 E. Tallmadge Ave., Akron 9, Ohio.
Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Ill.
Davis-Standard, Div. of Franklin Research Corp., Mystic, Conn.
Frank W. Egan & Co., South Adamsville Rd., Somerville, N. J.
Farrel-Birmingham Co., Inc., Inductomatic Extruder Division, Ansonia, Conn.
Hartig Extruders, Div. of Midland-Ross Corp., P. O. Box 531, Westfield, N. J.
Johnson Machinery Corp., 683 Frelinghuysen Ave., Newark 12, N. J.
Killion Tool & Mfg. Co., 56 Depot Street, Verona, N. J.
Modern Plastic Machinery Corp., 15 Union Street, Lodi, N. J.
National Rubber Machinery Co., 47 West Exchange Street, Akron 8, Ohio
Prodex Corp., King George Post Road, Fords, N. J.
John Royle & Sons, 10 Essex Street, Paterson 3, N. J.
Sterling Extruder Corp., 1112 Baltimore Avenue, Linden, N. J.
Welding Engineers, Inc., Norristown, Pennsylvania

** Life expectancy of 90% of all bearings.

*** Delivery time, as well as prices, should be substantiated in a formal quotation from the manufacturer.

# Has more machine types or sizes, in addition to tabulated models.

| Manufacturer* | Batt (Cont'd.) | Davis-Standard # | | | | | | Egan # | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Extruder size or model number | BE-150 | 1½ (15T) | 2½ (25T) | 3½ (35T) | 4½ (45T) | 6 (60T) | 8 (80T) | 2 | 2½ | 3½# |
| Screw: Number | One | One | One | One | One | One | One | One | One | One |
| Design type | See 1st pg. | Metering or to customers' specifications. → | | | | | | As required, depending on application. | | |
| Effective length, inches | - - | 30;37.2 | 50;61.5 | 70;86.1 | 69;90;111 | 91.8;120;148.2 | 122.4;160 | 40 | 60 | 84 |
| L/D ratio, excluding feed opening | 24:1 | 20:1, 24.8:1 | 20:1, 24.6:1 → | | 15.3:1, 20:1, 24.7:1 | | 15.3:1, 20:1 | 20 | 24 | 24 |
| Speed range, rpm | 6-38 | Up to 400 | Up to 200 | Up to 150 | Up to 130 | Up to 100 | Up to 75 | As required, depending on application. | | |
| Materials (base and surfacing): Screw | See 1st pg. | AISI 4140 heat-treated steel, flame-hardened and polished. → | | | | | | Steel, with flights & surfaces chrome-plated, stellited, nitrided, or pre-hardened. → | | |
| Cylinder | " | One-piece with Xaloy or Xaloy 306 liner. → | | | | | | One-piece heat-treated alloy steel with Xaloy or Xaloy 206 liner. → | | |
| Feed opening size, inches | " | 2x2-3/4 | 3-1/8x2½ | 4½ x 4½ | 6⅝ x 4½ | 7-3/4 x 9 | 10 x 8 | As required, depending on application. | | |
| Gear reduction type | " | Direct drive. | Double-reduction helical gears. → | | | | Double-red. Herr. | Herringbone. → | | |
| Thrust carrier: Type | " | Cylindrical roller bearing. → | | | | | | Roller thrust. → | | |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | 2,500# | 177,000 | 164,100 | 52,700 | 91,100 | 50,300 | 38,500 | 200,000 | 46,000 | 192,000 |
| Extrusion cylinder: Number of heating zones | 5;6## | 3;4 | 4;5 | 4;5 | 3;4;5 | 3;4;5 | 3;4 | 2 | 4 | 4 |
| Max. kw. demand on cylinder | 35;* | 9;12 | 20/25 | 28;35 | 30;40;50 | 42;56;70 | 60;80 | 16 | 28 | 42 |
| Lubricating system | See 1st pg. | Gravity feed. | Oil pump for bearings; dip for gears. | | Gravity feed. | Oil pump for bearings; dip for gears. | | Continuous forced feed. → | | |
| Drive motor, hp | 100 | 7½-10 | 25-40 | 50-60 | 75-100 | 150-200 | 200-300 | 10-15 | 15-30 | 25-50 |
| Extrusion capacity, lbs./hr. etc. (1st pg.) | 610 | 50# | 200# | 400# | 600# | 1,100# | 1,600# | 75 | 150 | 280 |
| Approx. heat-up time, min., etc. (1st pg.) | 90 | 20 | 20 | 30 | 35 | 45 | 60 | 30 | 30 | 30 |
| Heaters: Type | See 1st pg. | Thermofins (tubular heaters cast into finned aluminum). → | | | | | | Ceramic | Ceramic | Ceramic |
| Controls | Thermostat | Proportioning controllers for each cylinder zone. → | | | | | | Proportioning type. | | |
| Special features (included as standard) | See 1st pg. | Pre-wired control panel. Thrust & radial bearings. Water cooled feed section. Stainless-steel hopper with Shut-off & level indic. Screw flights extend beyond feed throat opening. One-piece cyl. H-d head clamp. Belt drive from motor. Removable feed throat bushing. → | | | | | | Pre-wired control panel. Pre-wired heater bands & thermocouples. Common piping for water & drain lines. Cut-off slide, sight glass, & emptying chute on hopper. Breaker plate. Head clamp. Safety guards. → | | |
| Optional features (available at extra cost) | " | L/D ratios to order. Cored or solid screws. Heads to order, with or without electric heating. Valved heads. Vented-barrel extruders. | | | | | | Screw-speed indic. Back-press. gage. Melt-temp. indic. assembly. Screw extractors. Heater burn-out lights. Motor-load indicators. Pneu. head clamps. Adaptor with cartridge-type filters. Stepless temp. controller. Timers for preheating cylinders. Cal-rod, induction-type, or thermostrip heaters. Var.-pitch flights & torpedo patterns. → | | |
| Approx. floor space (L x W), feet | 18x4-2/3 | 4½ x 1½ | 7 x 2 | 9 x 2½ | 12 x 3 | 15 x 3½ | 20 x 4½ | 8 x 4 | 11 x 4 | 13 x 5 |
| Approx. delivery time, weeks*** | 20 | 6 - 8 | 6 - 8 | 6 - 8 | 6 - 8 | 10 - 12 | 18 - 20 | 2 | 2 | 4 |
| | Footnotes: See 1st pg. | # At 3,000 psi. pressure | | | | | | # Heavy-duty, high-pressure designs. | | |

| Manufacturer* | Egan (Cont'd.) | | | Farrel-Birmingham # | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Extruder size of model number | 4½# | 6# | 8# | 2½" | 4½" | 6" | 13x8½" | 8½" | 12" |
| Screw: Number | One | One | One | One | One | One | One | One | One |
| Design type | (See above) → | | | Constant-pitch or to customer's specs. | | Metering or full-flighted. | Hot feed, full-flighted. | Cold feed, metering. → | |
| Effective length, inches | 108 | 144 | 192 | 50 | 90 | 60-120 | 54 | 168 | 144-264 |
| L/D ratio, excluding feed opening | 24 | 24 | 24 | 16:1;20:1 | 16:1;20:1 | 10:1 | 5:1 | To suit material. → | |
| Speed range, rpm | (See above) → | | | 7-120 | 5-90 | 10-100 | 4-40 | 8-80 | 8-75 |
| Materials (base and surfacing): Screw | (See above) → | | | Alloy steel. → | | Alloy steel with stellited thread tips. → | | | |
| Cylinder | (See above) → | | | Xaloy or Xaloy 306. → | | Meehanite, cast steel or welded steel with Xaloy liners. → | | | |
| Feed opening size, inches | (See above) → | | | 2½ | 4½ dia. | To suit material. | To take batch from Banbury | To suit material. → | |
| Gear reduction type | Herringbone. → | | | Helical | Herring-bone | Double-reduction herringbone. → | | | |
| Thrust carrier: Type | Roller thrust. → | | | Tapered or flat roller. | | Flat roller. → | | | |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | 192,000 | 192,000 | 192,000 | 77,500# | 20,500# | Five-year minimum life. → | | | |
| Extrusion cylinder: Number of heating zones | 4 or 5 | 4 or 5 | 4 or 5 | 2 or 3 | 3 or 4 | Depends on number of cylinder sections. → | | | |
| Max. kw. demand on cylinder | 72 | 160 | 240 | 13.5 | 33.6 | - - | - - | - - | - - |
| Lubricating system | (See above) | | | Immersion. → | | Pump and splash. → | | | |
| Drive motor, hp | 50-100 | 75-200 | 100-500 | 20## | 60## | 60-125## | 50-125## | 100-300## | 100-600## |
| Extrusion capacity, lbs./hr., etc. | 480 | 780 | 1,600 | 100-150 | 300-450 | 1,000 | 3,000 | 1,500 | 3,000 |
| Approx. heat-up time, minutes, etc. | 30 | 30 | 30 | 20 | 45 | - - | - - | - - | - - |
| Heaters: Type | Ceramic | Ceramic | Ceramic | Induction | Induction | Induction, Steam, or oil. | Steam, oil, or Dowtherm. → | | |
| Controls | Proportioning type → | | | Automatic | Automatic | Manual or automatic. → | | | |
| Special features (available at extra cost) | (See above) → | | | Induction heating. → | | Central control panel. Can be regulated to Banbury discharge cycle. Pneumatic hopper ram. → | | | |
| Optional features (available at extra cost) | " → | | | Forced-air cooling. → | | | | | |
| | | | | Other L/D ratios. → | | One additional die heat zone control. Other L/D ratios. Melt-temp. indic. Var. dies. Hydraulic breechblock. Hydr. or manual "C" clamp. Vented cylinders and special screw types. → | | | |
| Approx. floor space (L x W), feet | 15 x 7 | 17 x 8 | 19 x 9 | 6 x 2 | 12 x 4 | 12x4-2/3 | 10-3/4 x 6-3/4 | 27 x 7 | 25x7½ to 40 x 9 |
| Approx. delivery time, weeks*** | 8 | 10 | 12 | 6 | 10 | 20 and up. | | | |
| | # Same as above. | | | # Minimum. Average life is five times minimum. ## At 1.5 S.F. | | | | | |

| Manufacturer* | Hartig | | | | | Johnson | | Killion | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Extruder size or model number | 1½" (Model TA) | 2½" | 3½" | 4½" | 6" | 1½" | 2½" | 3/4" Lab. | 1" Lab. | 1½" Lab. |
| Screw: Number | One | One | One | One | One | One | One | One | One | One |
| Design type | Various design types available. → | | | | | For all materials. → | | To suit material. → | | |
| Effective length, inches | 32½ | 53 | 74* | 95 | 126 | 31½ | 52½ | 45 | 20 | 30 |
| L/D ratio, excluding feed opening | 20:1 | 20:1 | 20:1 | 20:1 | 20:1 | 21:1 | 21:1 | 20:1 | 20:1 | 20:1 |
| Speed range, rpm. | 25-125 | 10-125 | 10-100 | 10-85 | 85(normal) | 12-200 | 9-150 | 25-50 or 15-150 | 15-150 | 20-140 |
| Materials (base and surfacing): Screw | Hardened alloy steel. | Alloy steel with flame-hardened or hard-surfaced flights. → | | | | Chrome-plated, hardened alloy steel. → | | Flame-hardened alloy steel. → | | |
| Cylinder | Steel with Xaloy or Xaloy 306 integral lining. → | | | | | One-piece alloy steel with Xaloy liner. → | | Stainless steel with Xaloy liner. → | | |
| Feed opening size, inches | 2½ | 3 | 4 | 5 | 6½ | 2½ x 4 | 3½ x 4½ | 3/4 x 1½ | 1 x 1½ | 1½ x 2 |
| Gear reduction type | Torque-arm reducer. | Herringbone gear type. → | | | | Enclosed herringbone → | | - - | Variable drive. | Flange-mounted Gem reducer. → |
| Thrust carrier: Type | Spherical roller-thrust bearing. | Roller type. → | | | | Full-thrust spherical roller bearings. → | | Radial thrust ball bearing. → | | |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | 250,000 | 20,000 minimum. → | | | | 250,000# | 95,000# | - - | - - | - - |
| Extrusion cylinder: | | | | | | | | | | |
| Number of heating zones | 2 | 3 | 3 | 4 | 4 | 2 | 3 | 2 | 2 | 3 |
| Max. kw. demand on cylinder | 9.2 | 14.3 | 26 | 44 | 68 | 6 | 18 | 1.5 | 1.6 | 6 |
| Lubricating system | Oil bath | Recirculating oil bath type. → | | | | Forced feed through thrust assembly. → | | Splash from housing. → | | |
| Drive motor, hp | 5 | 15-25 | 25-40 | 50-75 (50 normal) | 100-150 | 5-10 | 15-25 | 3/4 | 3/4 or 1 | 3½ |
| Extrusion capacity, lbs./hr. etc. | 35-45 | 90-120# | 180-240# | 300-400# | 500-700# | 55 | 220 | 6 | 14 | 35 |
| Approx. heat-up time, minutes, etc. | 25 | 25 | 25 | 25 | 25 | 26 | 32 | 20 | 30 | 30 |
| Heaters: Type | Extruded aluminum type. → | | | | | Tubular heater → | | Electric band-type → | | |
| Controls | Proportioning pyrometer type. → | | | | | Proportioning. → | | Robt.Shaw-Simpson → | | Wheelco or West |
| Special features (included as standard) | Torque-resisting barrel support. Air and/or water cooling. → | | | | | Replaceable heaters. Motor interlock. Heater-indic.lights. Zone air-cooling. Pre-wired control panel. → | | Water-cooled hopper. → | | |
| Optional features (available at extra cost) | Vent. Valving. Complete line of heads and adaptors. → | | | | | Induction heating. Press.-control heads. → | | Special screws and dies. → | | |
| Approx. floor space (L x W), feet | 5 x 2 | 5 x 3 | 6 x 3½ | 7 x 4 | 8½ x 4 | 5-3/4x2 | 8½ x 2½ | 3 x 1½ | 4 x 2 | 5 x 3 |
| Approx. delivery time, weeks*** | - - | - - | - - | - - | - - | 3 | 3 | 2 | 2 | 7 |

\# Nominal

\# At 10,000 psi. and 100 rpm.

| Manufacturer* | Killion (Cont'd) | | M P M | | | | | | N R M # | |
|---|---|---|---|---|---|---|---|---|---|---|
| Extruder size or model number | 2½" Lab. | 3½" Lab. | 1½" | 2½" | 3½" | 4½" | 6" | 8" | Model 55 1½" | Model 55 2½" |
| Screw: Number | One | One | One | One | One | One | One | One | One | One |
| Design type | (Above) → | | Four standard design types available; others to customers' orders. → | | | | | | (See following page) | |
| Effective length, inches | 50 | 70 | 30 | 50 | 70 | 90 | 120 | 160 | 30 | 50 |
| L/D ratio, excluding feed opening | 20:1 | 20:1 | 20:1 | 20:1 | 20:1 | 20:1 | 20:1 | 20:1 | 20:1 | 20:1 |
| Speed range, rpm. | 15-125 | 15-110 | 16-113 | 7-85 | 7-85 | 5-70 | 6-76 | 8-72 | 12-80 | 5-74;11-72 |
| Materials (base and surfacing): Screw | (Above) → | | 4140 steel, Flame-hardened lands, chrome-plated. → | | | | | | (See following page) | |
| Cylinder | " → | | Xaloy or Xaloy 306 liner. → | | | | | | " " | " |
| Feed opening size, inches | 2½ x 3½ | 3½ x 4½ | 1½ x 3 | 2½ | 3½ | 4½ | 6 | 8 | 1½ x 3 | 2½ |
| Gear reduction type | (Above) | Gear reducer. | Silent chain. | Herringbone type. → | | | | | Roller chain. | Cone worm or single helical. |
| Thrust carrier: Type | " | Roller thrust ball bearing. | Roller thrust. → | | | | | | Ball bearing. | Roller type. |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | - - | - - | 82,000 | 168,000 | 261,000 | 155,000 | 216,000 | 42,000 | 500 min.## 2,500 ave. | 63,000 |
| Extrusion cylinder: | | | | | | | | | | |
| Number of heating zones | 3 | 3 | 2 | 4 | 4 | 5 | 5 | 6 | 2 | 4 |
| Max. kw. demand on cylinder | 27 | 30 | 6.2 | 13.2 | 26.4 | 42.5 | 62.0 | 125.0 | 5.1 | 13.75 |
| Lubricating system | (Above) | Oil pump | Submerged dip. → | | | | | | Automatic. → | |
| Drive motor, hp. | 7½ or 10 | 25 | 5 | 20-25 | 30-40 | 75-100 | 125-150 | 200-300 | 5 | 15 & 25 |
| Extrusion capacity, lbs./hr., etc. | 65-90 | 180-200 | 25-35 | 200 | 385 | 600 | 900 | 1,600 | 30-42* | 80-115* |
| Approx. heat-up time, minutes, etc. | 30 | 45 | 35-40 | 35-40 | 35-40 | 35-40 | 35-40 | 35-40 | 45 | 50 |
| Heaters: Type | (Above) → | | Cast-in band or induction heaters. → | | | | | | Cast-in | Cast-in** |
| Controls | Wheelco or West. → | | Proportioning type. → | | | | | | (See following page) | |
| Special features (included as standard) | (Above) → | | Tachometers. Ammeters. Melt thermocouples. Pressure gages. → | | | | | | " " | " |
| Optional features (available at extra cost) | " → | | Hydraulic pressure system for controlling & valving pressure in extruder by moving screw. → | | | | | | Balanced heat contr. | (See following page). |
| Approx. floor space (L x W), feet | 6 x 3 | 8 x 4 | 7 x 4 | 10 x 4 | 12 x 4 | 15 x 5 | 18 x 5 | 22 x 6 | 4½x1-2/3*** | 4½x2½*** |
| Approx. delivery time, weeks*** | 7 | 8 | 8 - 10 | 12 | 12 | 14 | 16 | 22 | 4 | 4 |

Footnotes: See Following Page.

## N R M # (Cont'd)

| | | | | |
|---|---|---|---|---|
| Manufacturer* | | | | |
| Extruder size or model number | 3½" | 4½" | 6" | 8" |
| Screw: Number | One | One | One | One |
| Design type | Four std. types (full-flighted, high- or low-compression, metering, smooth torpedo) # | | | |
| Effective length, inches | 70 | 90 | 120 | 160 |
| L/D ratio, excluding feed opening | 20:1 | 20:1 | 20:1 | 20:1 |
| Speed range, rpm. | 4.4-70.4; 12-73 | 6-72; 4-70 | 6-72; 3.5-69 | 5-56; 3-54 |
| Materials (base and surfacing): Screw | Chrome-plated alloy steel, surface-hardened flight lands. | | | |
| Cylinder | One-piece steel with integral Xaloy 306 liner. | | | |
| Feed opening size, inches | 3½ | 4½ | 6 | 8 |
| Gear reduction type | Herringbone gear. | | | |
| Thrust carrier: Type | Roller type. | | | |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | 18,000 | 13,800 | 8,250 | 11,400 |
| Extrusion cylinder: Number of heating zones | 4 | 5 | 5 | 6 |
| Max. kw. demand on cylinder | 25.8 | 38.5 | 62 | 100 |
| Lubricating system | Automatic | | | |
| Drive motor, hp. | 25 std. | 50 & 75 | 100 or 125 | 150 |
| Extrusion capacity, lbs./hr., etc. | 160-230* | 275-375* | 450-675* | 1,200-1,600* |
| Approx. heat-up time, minutes, etc. | 90-100 | 100 | 100 | 110 |
| Heaters: Type | Cast-in** | Cast-in | Cast-in | Cast-in |
| Controls | Proportioning. | | | |
| Special features (included as standard) | Removable cylinder covers. Pre-wired, fabricated steel control cabinet. Quick-changing die adaptor gate. Fabricated steel base. | | | |
| Optional features (avail. at extra cost) | Drive motor. Choice of drive ratios. Extruders also available in oil-heated, steam-heated, and devolatilizing models. | | | |
| Approx. floor space (L x W), feet | 9½ x 3*** | 12 x 3½*** | 14-3/4 x 4 *** | 20x8*** |
| Approx. delivery time, weeks*** | 4 - 6 | 7 - 8 | 7 - 8 | 12 - 14 |

# Also available in nylon or Dulmage types.
##At 18,500 psi. and 50 rpm.
* Nominal.
**Available with induction heating.
***Not including electrical control cabinet.

## Prodex

| | | | | | | |
|---|---|---|---|---|---|---|
| Manufacturer* | | | | | | |
| Extruder size or model number | 1-3/4" | 2½" | 3½" | 4½" | 6" | 8" |
| Screw: Number | One | One | One | One | One | One |
| Design type | Metering. | | | | | |
| Effective length, inches | 35;42 | 50;60 | 70;84 | 90;108 | 120;144 | 160;192 |
| L/D ratio, excluding feed opening | 20:1, 24:1, 30:1 | | | | | |
| Speed range, rpm. | 20-250 | 20-200 | 20-110 | 20-90 | 10-75 | 10-65 |
| Materials (base and surfacing): Screw | Stellite-tipped 4140 steel. | | | | | |
| Cylinder | Xaloy. | | | | | |
| Feed opening size, inches | 2½ x 4½ | 3½ x 4½ | 4½ x 5½ | 6 x 7 | 7½ x 9 | 12 x 14 |
| Gear reduction type | Herringbone. | | | | | |
| Thrust carrier: Type | Spherical roller. | | | | | |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | 220,000 | 150,000 | 105,000 | 97,000 | 75,000 | 70,000 |
| Extrusion cylinder: Number of heating zones | 2-3 | 4 | 4 | 4 | 5 | 6 |
| Max. kw. demand on cylinder | 7 | 15 | 35 | 50 | 90 | 125 |
| Lubricating system | Forced-feed gear pump. | | | | | |
| Drive motor, hp. | 7½ - 10 | 20 - 30 | 40 - 50 | 60 - 75 | 125-150 | 200-250 |
| Extrusion capacity, lbs./hr., etc. | 100 | 200 | 400 | 600 | 1,200 | 1,900 |
| Approx. heat-up time, minutes, etc. | 30 | 35 | 35 | 35 | 35 | 35 |
| Heaters: Type | Calrod. | | | | | |
| Controls | Proportioning. | | | | | |
| Special features (included as standard) | Venting valve, pressure gages, stock temperature controller. | | | | | |
| Optional features (avail. at extra cost) | Wattmeter. | Tachometer. | | | | |
| Approx. floor space (L x W), feet | 5 x 2½ | 8 x 3 | 10 x 4 | 12 x 4 | 17 x 4½ | 22 x 4½ |
| Approx. delivery time, weeks*** | 4 | 6 | 8 | 8 | 10 | 12 |

## Royle

| | | | | | | |
|---|---|---|---|---|---|---|
| Manufacturer* | | | | | | |
| Extruder size or model number | #2 (2½") | #4 (3½") | #2A (4½") | #3 (6") | #4A (8½") | #5A (10") |
| Screw: Number | One | One | One | One | One | One |
| Design type | Metering | Metering | Metering | Metering | Metering | Metering |
| Effective length, inches | 60 | 84 | 90 | 120 | 127½ | 140 |
| L/D ratio, excluding feed opening | 24:1 | 24:1 | 20:1 | 20:1 | 15:1 | 14:1 |
| Speed range, rpm. | 20-200 | 18-180 | 18-180 | 18-180 | 10-100 | 10-100 |
| Materials (base & surfacing): Screw | Stainless steel, hard-surfaced weld. | | | | | |
| Cylinder | Steel with removable Xaloy liner. | | | | | |
| Feed opening size, inches | 2½x2-3/4 | 4½x4-5/16 | 5½x4-5/16 | 7x7-3/8 | 10½x12-1/8 | 10½x12-1/8 |
| Gear reduction type | Worm | Worm | Opposed helical. | | | |
| Thrust carrier: Type | Flat roller bearings. | | | | | |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | 163,500 | 150,000 | 120,000 | 63,000 | 50,000 | 40,000 |
| Extrusion cylinder: Number of heating zones | 4 | 4 | 3 | 3 | 3 | 3 |
| Max. kw. demand on cylinder | 27 | 51 | 54 | 85 | 108 | 132 |
| Lubricating system | Self-enclosed gravity flow with positive feed. | | | | | |
| Drive motor, hp. | 40 | 75 | 125 | 200 | 300 | 400 |
| Extrusion capacity, lbs./hr., etc. | 200 | 400 | 700 | 1,150 | 1,800 | 2,500 |
| Approx. heat-up time, minutes, etc. | 20 | 20 | 30 | 30 | 30 | 30 |
| Heaters: Type | Tubular resistance heaters. | | | | | |
| Controls | Proportioning. | | | | | |
| Special features (included as standard) | Safety head bolts. Common housing for gear & thrust carrier. Dual voltage control. Hi-velocity evaporating cooling. Spirod radiant heating. | | | | | |
| Optional features (avail. at extra cost) | Vented and 2-stage extrusion. Controlled-velocity flow. Other screw sizes, L/D ratios, and drive sizes on request. | | | | | |
| Approx. floor space (L x W), feet | 7 x 2 | 8½ x 2½ | 9 x 4 | 13 x 4½ | 14 x 5 | 16 x 6 |
| Approx. delivery time, weeks*** | - - | - - | - - | - - | - - | - - |

## Sterling

| | | | | |
|---|---|---|---|---|
| Manufacturer* | | | | |
| Extruder size or model number | 1½" | 2" | 2½" | 3½" |
| Screw: Number | One | One | One | One |
| Design type | Plastic and metering type. | | | |
| Effective length, inches | 35½ | 42 | 52½ | 73½ |
| L/D ratio, excluding feed opening | 20:1 | 20:1 | 20:1 | 20:1 |
| Speed range, rpm. | 0-110 | 0-100 | 0-95 | 0-90 |
| Materials (base & surfacing): Screw | Chrome-molybdenum steel, flame-hardened. | | | |
| Cylinder | Xaloy | Xaloy | Xaloy | Xaloy |
| Feed opening size, inches | 1½ | 3 | 3 | 4 |
| Gear reduction type | Herringbone gear reducer. | | | |
| Thrust carrier: Type | Self-aligning spherical roller thrust bearing. | | | |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | # | # | # | # |
| Extrusion cylinder: Number of heating zones | 2 | 3 | 3 | 3 |
| Max. kw. demand on cylinder | 10½ | 15½ | 22½ | 30 |
| Lubricating system | Forced lubrication. | | | |
| Drive motor, hp. | 3 - 10 | 7½ - 15 | 15 - 25 | 30 - 60 |
| Extrusion capacity, lbs./hr., etc. | 55 | 100 | 150 | 320 |
| Approx. heat-up time, minutes, etc. | 25 | 25 | 25 | 30 |
| Heaters: Type | Mica band, cast-in alum. Calrod, Thermastrip. | | | |
| Controls | Proportioning or saturable core reactor controls. | | | |
| Special features (included as standard) | Water/steam barrel cooling or air cooling. Clamp-type closure or swing bolts. | | | |
| Optional features (avail. at extra cost) | Pressure gages. Melt thermocouples. Tachometers. L/D Ratios of 15:1, 24:1, and 30:1. | | | |
| Approx. floor space (L x W), feet | 3½ x 3 | 5 x 4½ | 5½ x 4½ | 7 x 5 |
| Approx. delivery time, weeks*** | 3 - 4 | 3 - 4 | 3 - 4 | 6 |

# Several thrust bearing assemblies available for each extruder size with minimum life of 16,000 hrs. and average life of 80,000 hrs.

| | Sterling (Cont'd) | | Welding Engineers | | | | | |
|---|---|---|---|---|---|---|---|---|
| Manufacturer* | | | | | | | | |
| Extruder size or model number | 4½* | 6* | 2* Special | 2* 2052VI | 2.8* 2852VI | 3½* H350CDI | 4½* IH4552VI | 6* 6052HV2 |
| Screws: Number | One | One | Two | Two | Two | Two | Two | Two |
| Design type | Same as preceding page. | | Full-Flighted, metering, or special types. → | | | | | |
| Effective length, inches | 93½ | 126 | 30-84 | 50 | 70 | 147 | 112½ | 150 |
| L/D ratio, excluding feed opening | 20:1 | 20:1 | 25-42 | 25 | 25 | 20 | 25 | 25 |
| Speed range, rpm. | 0-90 | 0-90 | 150 max. | 150 max. | 150 max. | 150 max. | 150 max. | 150 max. |
| Materials (base and surfacing): Screw | Same as preceding page. | | Stellited stainless steel. → | | | | | |
| Cylinder | Xaloy | Xaloy | Xaloy 306. → | | | | | |
| Feed opening size, inches | 6 | 7 | 3½ | 3½ | 5 | 6 | 8 | 10 |
| Gear reduction type | Same as preceding page. | | Spur gear | Spur gear | Planetary. → | | | |
| Thrust carrier: Type | " | " | Ball bearing. → | | Spherical roller bearing. → | | | |
| B-10 service life,** hrs. @ 100 rpm. & 5,000 psi. pressure | # | # | 80,000## | 80,000## | 100,000## | 120,000## | 160,000### | 160,000### |
| Extrusion cylinder: Number of heating zones | 4 | 4 | 5 - 8 | 6 | 6 | 5 | 6 | 6 |
| Max. kw. demand on cylinder | 48 | 90 | 20 | 14 | 28 | 56 | 56 | 152 |
| Lubricating system | Forced lubrication. → | | Splash type. → | | | Forced lubrication. → | | |
| Drive motor, hp. | 50 - 100 | 100-200 | 10 | 10 | 25 | 100 | 150 | 300 |
| Extrusion capacity, lbs./hr., etc. | 600 | 1,000 | 125* | 125* | 300* | 1,000* | 1,000* | 2,000* |
| Approx. heat-up time, minutes, etc. | 35 | 35 | 45 | 45 | 60 | 75 | 75 | 90 |
| Heaters: Type | Same as preceding page. | | Hot oil circulation. → | | | | | |
| Controls | " | " | Thermostat → | | | | | |
| Special features (included as standard) | " | " | Compounder-Extractor-Extruder. → | | | | | |
| | | | Lab. test unit. Can be assembled for various barrel lengths & types. | Small vent lab. or production unit. | Small vent unit. → | | Large vent unit. Adjustable pressure treatment. → | |
| Optional features (avail. at extra cost) | " | " | All types of variable-speed drives, explosion-proof construction, quick-opening dies, screening heads, strand dies, pelletizing systems, special dies and other features to meet individual requirements. → | | | | | |
| Approx. floor space (L x h), feet | 10 x 5 | 14 x 6 | 7 x 2 | 7 x 2 | 8 x 3 | 14 x 4 | 14 x 4 | 20 x 5 |
| Approx. delivery time, weeks*** | 6 - 8 | 10 | 24 | 20 | 24 | 30 | 30 | 36 |

#See preceding page.

* When processing raw crumb feed of low-pressure polyethylene.
## Service life, hrs., at 100 rpm. and 2,000 psi.
### Service life, hrs., at 100 rpm. and 4,000 psi.

# PT's Classified List of Auxiliary Equipment for Extrusion and Blow Molding

### Conveyors

Atlas Machinery & Tool Corp., 259 Hackensack St., East Rutherford, N.J.
R. N. Bailey & Co., Inc., 11 West 42 Street, New York 36, N.Y.
Brown Machine Co., Beaverton, Michigan
Dracco Div. of Fuller Co., P.O. Box 1794, Cleveland 5, Ohio
Frank W. Egan & Co., S. Adamsville Rd., Somerville, N.J.
Entoleter Div., Safety Industries, Inc., P.O. Box 904, New Haven, Conn.
Goulding Manufacturing Co., 2929 River Street, Saginaw, Mich.
Hartig Extruders, Div. of Midland-Ross Corp., P.O. Box 531, Westfield, N.J.
Island Equipment Corp., 27-01 Bridge Plaza, Long Island City 1, New York
Mercury Heat Sealing Equipment Co., 2601 N. Howard St., Philadelphia 33, Pa.
Mercury Industries, Inc., 365 Broadway, Hillside, N.J.
Michigan Oven Co., 415 Brainard Street, Detroit 1, Mich.
National Rubber Machinery Co., 47 W. Exchange St., Akron 8, Ohio
A.B. Oliver Corp., Farquhar Div., 142 N. Duke St., York, Pa.
Plastic Fabricants, Div. of Woodman Co., 647 E. College Ave., Decatur, Ga.
Proctor & Schwartz, Inc., Seventh St. & Tabor Rd., Philadelphia 20, Pa.
Rainco Mfg., Inc., P.O. Box 788, Franklin Pa.
Rapids Machinery Co., Inc., 889 11th St., Marion, Iowa
Robbins Plastic Machinery Corp., 1430 Mishawaka St., Elkhart, Ind.
Robinson Air-Activated Conveyor Systems, Div. of Morse Boulger Destructor Co., 80 Fifth Avenue, New York, N.Y.
S. M. C. Special Machine Corp., 149 Grand St., New York 13, N.Y.
Spencer Turbine Co., 486 New Park Ave., Hartford 6, Conn.
Sprout, Waldron & Co., Inc., Muncy, Pa.
Standard Conveyor Co., 15-N West Second St., North St. Paul 9, Minn.
Syntron Co., 390 Lexington Avenue, Homer City, Pa.
Thoreson-McCosh, Inc., 18208 W. McNichols Rd., Detroit 19, Mich.
John Verduin Machine Corp., 351 Tenth Avenue, Paterson 4, N.J.
C. H. Whitlock Associates, 21655 Coolidge Highway, Oak Park 37, Mich.

### Cylinders, Extruder

Frank W. Egan & Co., S. Adamsville Rd., Somerville, N.J.
Hale & Kullgren, Inc., 613 E. Tallmadge Ave., Akron 10, Ohio
Industrial Research Laboratories, Div. Honolulu Oil Corp., 961 E. Saluson Ave., Los Angeles 11, Calif.

*(Continued on next page)*

Johnson Machinery Co., 683 Frelinghuysen Ave., Newark 5, N.J.
National Rubber Machinery Co., 47 W. Exchange St., Akron 8, Ohio

### Dies, Extruder

Akron Preform Mold Co., 2038 Main St., Cuyahoga Falls, Ohio
Al-Be Industries, 6103 Clara Street, Bell Gardens, Calif.
Allied Engraving & Stamping Co., 17-21 Elm St., Buffalo 3, N.Y.
Allied Plastics Supply Corp. 75 Cliff Street, New York 38, N.Y.
Beel Engineering Co., 411 Mulberry St., Newark 2, N.J.
Conneaut Rubber & Plastics Co., Commerce St., Conneaut, Ohio
Danielson Mfg. Co., subsidiary of Nicholson File Co., 260 Holt St., Danielson, Conn
Frank W. Egan & Co., S. Adamsville Rd. Somerville, N.J.
General Machine & Tool Works, Inc., Walled Lake, Michigan
Goulding Mfg. Co., 2929 River St., Saginaw, Mich.
Hale & Kullgren, Inc., 613 E. Tallmadge Ave., Akron 10, Ohio
Hartig Extruders, Div. of Midland-Ross Corp. P.O. Box 531, Westfield, N.J.
Industrial Engineering Service, Washington St., S. Easton, Mass.
Jet Specialties Co., Inc., 941 N. Eastern Ave., Los Angeles 63, Calif.
Johnson Mfg. Co., 229 S. Main St., Chippewa, Wis.
Kel-Min Co., Old State Road, Middlefield, Ohio
E. B. Kingman Co., Inc., 96 Exchange St. Leominster, Mass.
L & P Tool Co., 2861 Sidney Ave., Cincinnati 25, Ohio
Libbert Tool & Die, 5331 Whitesettlement Rd., Fort Worth 14, Tex.
Maynard Plastics Co., 49 Congress St., Salem Mass.
National Plastics, Inc., 2326-30 McCella Ave., Knoxville 1, Tenn.
National Rubber Machinery Co., 47 West Exchange St., Akron 8, Ohio
Newark Die Co., 20 Scott St., Newark, N.J
New England Die Co., 64 Floral St., Taunton, Mass.
Plaskolite, Inc., 222 Neilston St., Columbus 15, Ohio
Plastic Mold Tool & Die Co., 1 Maple St., E. Rutherford, N.J.
Progressive Tool & Die Co., 25 Foster St., Worcester 8, Mass.
Robbins Plastic Machinery Corp., 1430 Mishawaka St., Elkhart, Ind.
Roehlen Engraving Works, Inc., 324 St. Paul St., Rochester 5, N.Y.
John Royle & Sons, 10 Essex St., Patersor 3, N.J.
Sandee Mfg. Co., 5050 W. Foster Ave., Chicago 30, Ill.
Stricker-Brunhuber Corp., 19 W. 24 St., New York 10, N.Y.
Superior Plastics Inc., 410-430 N. Oakley Blvd., Chicago 12, Ill.
Sussex Plastic Co., 85 Academy St., Belleville 9, N.J.
Thermoplastic Processes, Inc., 1949 Valley Rd. Stirling, N.J.
Vern Emery Co., 10647 Wixom St., Sun Valley, Calif.
Western Supplies Co., 2920 Cass Ave., St. Louis 6, Mo.

### Drying Ovens

Ball & Jewell, Inc., 24-28 Franklin St. Brooklyn 22, N.Y.
Blaw-Knox Co., 300 Sixth Ave., Pittsburgh 22, Pa.
G. S. Blodgett Co., 50 Lakeside Ave., Burlington, Vt.
E. B. Blue Co., Connecticut Ave., S. Norwalk, Conn.
Brosites Machine Co., 50 Church St., New York 7, N.Y.
Cleveland Process Corp., 1965 E. 57th St., Cleveland 3, Ohio
Arthur Colton Co., 3400 E. Lafayette St. Detroit 7, Michigan
F. C. Dawson Engineering Co., Rt. 641, Washington St., Canton, Mass.
Despatch Oven Co., 619 S.E. Eighth St., Minneapolis 14, Minn.
J. E. Doyle Co., 1220 W. Sixth St., Cleveland 13, Ohio
Drying Systems Co., 1800 Foster Ave., Chicago 40, Ill.
Dryomatic Corp., 806 N. Fairfax St., Alexandria, Va.
Eclipse Fuel Engineering Co., 1100 Buchanan St., Rockford, Ill.
Falcon Equipment Co., 13th St., New Brighton, Pa.
Finn & Fram, 9765 Shadow Island Drive, Sunland, Calif.
Foremost Machine Builders, Inc., 83 Dorsa Avenue, Livingston, N.J.
Glenn Electric Heater Corp., 372 Jeliff Ave., Newark 8, N.J.
Grieve-Hendry Co., 1401 W. Carroll Ave., Chicago 7, Ill.
Injection Molders Supply Co., 3514 Lee Rd., Cleveland 20, Ohio
Lydon Brothers, Inc., 85 Zabriskie St., Hackensack, N.J.
Michigan Oven Co., 415 Brainard St., Detroit 1, Mich.
The Miskella Infra-Red Co., E. 73rd St. & Grand Ave., Cleveland 4, Ohio
Proctor & Schwartz, 7th St. & Tabor Rd., Philadelphia 20, Pa.
Radiant Heat Enterprises, Inc., 630 Morris & Essex Turnpike, Short Hills, N.J.
The Rainville Co., Inc., 657 Franklin, Garden City, New York
W. S. Rockwell Co., Eliot St., Fairfield, Conn.
Somerset Industrial Designs, Inc., P.O. Box 562, Somerville, N.J.
Stromes Systems, Inc., 411 East 108th St., New York 29, N.Y.
Thermomat Co., Inc., 300 Maple Ave., Trenton 8, N.J.
Thoreson-McCosh, Inc., 18208 W. McNichols Rd., Detroit 19, Mich.
Trent, Inc., 201 Leverington Ave, Philadelphia 27, Pa.
John Waldron Corp., New Brunswick, N.J.
Wyssmont Co., Inc., 42-07D 27th St., Long Island City 1, N.Y.
Young Brothers Co., 1832 Columbus Rd., Cleveland 13, Ohio
Zack Industries, 185 Goffle Rd., Hawthorne, N.J.

### Grinders & Granulators

Alsteele Engineering Works, Inc., 82 Herbert St., Framingham, Mass.
American Pulverizer Co., 1249 Macklind St., St. Louis 10, Mo.
Ball & Jewell, Inc., 24-28 Franklin St., Brooklyn 22, N.Y.
Brosites Machine Co., 50 Church St., New York 7, N.Y.
Cumberland Engineering Co., Inc., P.O. Box 216, Providence 1, Rhode Island
Doven Machine & Engineering, Inc., 2706 W. Van Buren St., Chicago 12, Ill.
Foremost Machine Builders, Inc., 83 Dorsa Avenue, Livingston, N.J.
Injection Molders Supply Co., 3514 Lee Road, Cleveland 20, Ill.
Mitts & Merrill, Inc., 1009 S. Water St., Saginaw, Mich.
National Rubber Machinery Co., 47 West Exchange St., Akron 8, Ohio
The Rainville Co., Inc., 657 Franklin, Garden City, New York
Spadone Machine Co., Inc., Connecticut Ave., S. Norwalk, Conn.
Van Dorn Iron Works Co., 2685 E. 79th St., Cleveland 4, Ohio

### Heads, Extruder

Atlas Machinery & Tool Corp., 259 Hackensack St., East Rutherford, N.J.
Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Illinois
Davis-Standard, Div. of Franklin Research Co., 12 Water St., Mystic, Conn.
Frank W. Egan & Co., S. Adamsville Rd., Somerville, N.J.
Hale & Kullgren, Inc., 613 E. Tallmadge Rd., Akron 9, Ohio
Hartig Extruders, Div. of Midland-Ross Corp., P.O. Box 531 Westfield, N.J.
National Rubber Machinery Co., 47 W. Exchange St., Akron 8, Ohio
John Royle & Sons, 10 Essex St., Paterson 3, N.J.

### Hopper Dryers

Goulding Mfg. Co., 2929 River St., Saginaw, Mich.
National Rubber Machinery Co., 47 West Exchange St., Akron 8, Ohio
The Rainville Co., Inc., 657 Franklin, Garden City, New York
Thoreson-McCosh, Inc., 18208 W. McNichols Rd., Detroit 19, Mich.
Universal Dynamics Corp., Box 9814, Arlington 9, Va.
C. H. Whitlock Associates, 21655 Coolidge Highway, Oak Park 37, Mich.

### Motors & Drives, Extruder

Atlas Machinery & Tool Corp., 259 Hackensack St., East Rutherford, N.J.
Electro Devices Inc., 4-6 Godwin Ave., Paterson, N.J.
Farrel-Birmingham Co., Ansonia, Conn.
General Electric Co., Apparatus Sales Div., 1 River Road, Schenectady, N.Y.
C. A. Litzler Co., Inc., 1817 Brookpark Rd., Cleveland 9, Ohio
The Oilgear Co., 1560 W. Pierce St., Milwaukee 4, Wis.
Patron Transmission Co., Inc., 129 Grand St., New York 13, N.Y.
Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio
Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.
Vickers, Inc., Administrative & Engineering Ctr., Detroit 32, Michigan

### Pelletizers, In-Line

Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Illinois
Frank W. Egan & Co., S. Adamsville Rd., Somerville, N.J.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Hartig Extruders, Div. of Midland-Ross Corp., P.O. Box 531, Westfield, N.J.
Johnson Machinery Co., 683 Frelinghuysen Ave., Newark 5, N.J.
Welding Engineers, Inc., Norristown, Pa.

### Pressure Regulators

Askania Regulator Co., 240 E. Ontario St., Chicago, Ill.
Clifton Hydraulic Press Co., 289 Alwood Rd., Clifton, N.J.
Devco Engineering, Inc., P.O. Box 387, Caldwell, N.J.
Fischer & Porter, 30 Warminster Rd., Hatboro, Pa.
Foxboro Co., Neponset Ave., Foxboro, Mass.
General Electric Co., Apparatus Sales Div., 1 River Rd., Schenectady, N.Y.
Leslie Co., Valley Brook & Grant Ave., Garwood, N.J.
Norwood Controls Unit, Detroit Controls Division of American-Standard, 934 Washington Street, Norwood, Massachusetts
The Powers Regulator Co., 3400 Oakton St., Skokie 34, Ill.
Sarco Co., Inc., 635 Madison Avenue, New York 22, N.Y.
Taylor Instrument Companies, 95 Ames St., Rochester 1, N.Y.
Vickers, Inc., Maple & Crooks Rd., Troy, Detroit 32, Mich.
Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N.J.
Wheelco Div., Barber-Coleman Co., 1300 Rock Street, Rockford, Ill.

### Screws, Extruder

Aluminum Company of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa
Atlas Machinery & Tool Corp., 259 Hackensack St., East Rutherford, N.J.
Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Illinois
Davis-Standard Div., Franklin Research Corp., 12 Water St., Mystic, Conn.
Frank W. Egan & Co., S. Adamsville Rd., Somerville, N.J.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Killion Tool & Mfg. Co., 56 Depot St., Verona, N.J.
National Rubber Machinery Co., 47 W. Exchange St., Akron 8, Ohio
John Royle & Sons, 10 Essex St., Paterson 3, N.J.
Wayne Machine & Die Co., 166 Broadway, Passaic, New Jersey

### Take-Away Equipment for Blow-Molding

Acme Machinery & Mfg. Co., 20 S. Broadway, Yonkers, N.Y.
Atlas Machinery & Tool Corp., 259 Hackensack St., East Rutherford, N.J.
Auto-Blow Corp., 401 Bishop Avenue, Bridgeport, Conn.
Barclay Industries Inc., 420 Lexington Ave., N.Y. (authorized agent for Fischer-Lohmar, Rohn, Germany)
Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Illinois
Blow-O-Matic Corp., 405 Central Avenue, Bridgeport, Conn.
Kautex—U. S. Sales Co., Inc., 133-10 32nd Ave., Flushing 54, New York

Moslo Machinery Co., 2443 Prospect Ave., Cleveland 15, Ohio. (By the injection process)
F. J. Stokes, 5500 Tabor Rd., Philadelphia 20, Pennsylvania

**Take-Away Equipment for Film & Sheet Extrusion**

Al-Be Industries, 6103 Clara St., Bell Gardens, Calif.
Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Illinois
Brown Machine Co., Beaverton, Mich.
Dilts Division, Black-Clawson Co., Inc., 46 N. First St., Fulton, N.Y.
John Dusenbery Co., Inc., 274 Grove Avenue, Verona, N.J.
Frank W. Egan & Co., S. Adamsville Rd., Somerville, N.J.
Fife Mfg. Co., P.O. Box 878, Oklahoma City 1, Oklahoma
Goulding Mfg. Co., 2929 River Street, Saginaw, Michigan
Hale & Kullgren, Inc., 613 E. Tallmadge Ave., Akron 10, Ohio
Hamilton Tool Co., Ninth & Hanover Sts., Hamilton, Ohio
Hartig Extruders, Div. of Midland-Ross Corp., P.O. Box 531, Westfield, N.J.
Hobbs Mfg. Co., 55 Salisbury Rd., Worcester 5, Mass.
Industrial Ovens, Inc., 13825 Triskett Rd., Cleveland 11, Ohio
Intercontinental Dyamics Corp., 170 Coolidge Ave., Englewood, N.J.
Johnson Mfg. Co., 229 S. Main St., Chippewa, Wis.
Oscar L. Judelshon, Inc., 148 Greene St., New York 11, N.Y.
Liberty Machine Co., Inc., 275 Fourth Avenue, Paterson, N.J.
C. A. Litzler, Inc., 1817 Brookpark Rd., Cleveland 9, Ohio
Mayflower Electronic Devices, Inc., 20 Industrial Ave., Little Ferry, N.J.
Mount Hope Machinery Co., 15 Fifth St., Taunton, Mass.
National Rubber Machinery Co., 47 W. Exchange St., Akron 8, Ohio
A. W. Peterson & Sons Die Co., 131 Prince St., New York, N.Y.
The North American Mfg. Co., 4455 E. 71st St., Cleveland, Ohio
Progressive Machine Co., Inc., 198 E. 25th Street, Paterson 4, N.J.
Robbins Plastic Machinery Corp., 1430 Mishawaka St., Elkhart, Ind.
John Royle & Sons, 10 Essex St., Paterson 3, N.J.

**Take-Away Equipment for Plastic Monofilament**

Foster & Allen, Inc., 628 South Ave., Garwood, N.J.
Robbins Plastic Machinery Corp., 1430 Mishawaka St., Elkhart, Ind.

**Take-Away Equipment for Plastic Pipe Extrusion**

Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Illinois
Hale & Kullgren, Inc., 613 East Tallmadge Ave., Akron 9, Ohio
Kel-Min Company, Middlefield, Ohio
Frank W. Egan & Co., S. Adamsville Rd., Somerville, N.J.
Robbins Plastic Machinery Corp., 1430 Mishawaka St., Elkhart, Ind.
John Royle & Sons, 10 Essex St., Paterson 3, N.J.

**Take-Away Equipment for Wire Coating**

Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Illinois
Frank W. Egan & Co., S. Adamsville Rd., Somerville, N.J.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
John Royle & Sons, 10 Essex St., Paterson 3, N.J.

**Temperature Regulators**

American Hydrotherm Corp., 10-55 Jackson Ave., Long Island City 1, N.Y.
American Instrument Co., Inc., 8050 Georgia Ave., Silver Spring, Md.
Askania Regulator Co., 240 E. Ontario St., Chicago, Ill.
Atlas Machinery & Tool Corp., 259 Hackensack St., East Rutherford, N.J.
Devco Engineering, Inc., P.O. Box 387, Caldwell, N.J.
Fischer & Porter, 30 Warminster Rd., Hatboro, Pa.
Foxboro Co., Neponset Ave., Foxboro, Mass.
General Electric Co., Apparatus Sales Div., 1 River Rd., Schenectady, N.Y.
Glenn Electric Heater, 372 Jeliff Ave., Newark 8, N.J.
Industrial Heater Co., 417 Canal St., New York, N.Y.
Industrial Manufacturing Corp., 31 E. Georgia St., Indianapolis 4, Ind.
Injection Molders Supply Co., 3514 Lee Rd., Cleveland 20, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Leslie Co., Valley Brook & Grant Ave., Garwood, N.J.
Mayer Refrigerating Engineers, Inc., Lincoln Park, N.J.
National Rubber Machinery Co., 47 W Exchange St., Akron 8, Ohio
Partiow Corp., 215 Campion Rd., New Hartford, N.Y.
The Powers Regulator Co., 3400 Oakton St., Skokie 34, Illinois
Pyrometer Instrument Co., Inc., 92 Portland Ave., Bergenfield 9, N.J.
The Rainville Co., Inc., 657 Franklin, Garden City, New York
Sarco Co., Inc., 635 Madison Avenue, New York 22, N.Y.
Sterling Inc., 5200 W. Clinton Ave., Milwaukee 18, Wis.
Taylor Instrument Companies, 95 Ames St., Rochester 1, N.Y.
Thoreson-McCosh, Inc., 18208 W. McNichols Rd., Detroit 19, Mich.
Thermo Electric Co., Inc., Saddle Brook, N.Y.
Thwing-Albert Instrument Co., 5398 Pulaski Ave., Philadelphia 44, Pa.
Vic Mfg. Co., 1317 Hawthorne Ave., Minneapolis, Minn.
Edwin L. Weigand Co., 7503 Thomas Blvd., Pittsburgh 8, Pa.
West Instrument Corp., 4363 W. Montrose, Chicago 41, Ill.
Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N.J.
Wheelco Division, Barber-Coleman Co., 1300 Rock Street, Rockford, Ill.

**Water Chillers**

Injection Molders Supply Co., 3514 Lee Rd., Cleveland 20, Ohio

**Water Troughs & Tanks**

Frank W. Egan & Co., S. Adamsville Rd., Somerville, N.J.
Hale & Kullgren, Inc., 613 E. Tallmadge Ave., Akron 9, Ohio
Hartig Extruders, Div. of Midland-Ross Corp., P.O. Box 531, Westfield, N.J.
Johnson Machinery Co., 683 Frelinghuysen Ave., Newark 5, N.J.
National Rubber Machinery Co., 47 W. Exchange St., Akron 8, Ohio
Robbins Plastic Machinery Corp., 1430 Mishawaka St., Elkhart, Ind.
John Royle & Sons, 10 Essex St., Paterson, N.J.

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**Note:** New address of **Modern Plastic Machinery Corp.** 64 Lakeview Avenue, Clifton, N. J. (Change came to us too late to me made in listing on page 73.)

**Correction:** The 6" Royle Extruder listed on page 76 as model #3 should be model #3A.

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# Blow Molding section follows:

# PT's Comparative Data on 1959 Blow-Molding Machines

## (Based on data submitted by the machine manufacturers)

| Manufacturer* | Acme | Atlas | Auto-Blow | | Barclay | | | |
|---|---|---|---|---|---|---|---|---|
| Machine name or model number | Model B | 1000 | 150-7 | 60-9 | BM 500 | BM500S | BM2000 | BM-5000SP |
| Type of preliminary operation for blow molding (extrusion, injection molding, etc.) | Extrusion | Extrusion | Extrusion | Extrusion | Extrusion | | | |
| Method of operation (automatic, semi-automatic, manual) | Automatic | Automatic | Automatic | Automatic | Automatic | | | |
| Number of molds | 2 | 2 or 4 | 2 ea. side | 2 | 1 | 1 or 2 | 1 or 2 | 1 or 2 |
| Number of pieces per cycle | 2 or more | 2 or 4 | 4 | 2 | 1 | 1 or 2 | 1 or 2 | 1 or 2 |
| Hopper capacity, lbs. | 50 ♦ | 50 ♦ | 50 ♦ | 50 ♦ | 50 ♦ | | | |
| Platen area, W x D, inches | 36 x 14 | 16 x 24 | 15 x 21½ | 10 x 10 | 5.12x8.67 | 10.24x 8.67 | 10.24x 11.80 | 12.60x 15.75 |
| Clamp tonnage or Mold closing force, tons. | 5.6 | 1.5 | 5.0 | 3.5 | 2.1 | 4.41 | 4.41 | 9.92 |
| Daylight opening, inches | 21 | 18 | 14.5 | 18.0 | 9.85 | 9.85 | 13.80 | 15.35 |
| Platen stroke, inches | 10 | 12 | 7.5 | 9.0 | 4.73 | 4.73 | 6.70 | 7.50 |
| Max. size of part moldable: Diameter, inches or W x D | 12 x 10 | 12 | 6 | 8 | (2.95 (Dia. | (2.95x7.87 ( L x W | (4.72 (Dia. | (5.5x10 (L x W |
| Length, inches | 34 | 24 | 32 | 32 | 8.67 | 8.67 | 11.80 | 15.75 |
| Projected cross-section area, sq. in. | 340* | 100* | 165* | 225* | 25.6 | 68.3 | 55.7 | 157.5 |
| Dry cycle time (without cooling), minutes. | .025 | .063 | .016 | .016 | .017 | .017 | .017 | .020 |
| Output, lbs./hr., of finished parts (in polyethylene) | 100 | 316 | 100 | 50 | 88 | 88 | 88 | 154 |
| Recommended preliminary machine size (also include L/D ratio for extruder, if used). | 3, 18:1 | 2½, 24:1 | 2½, 20:1 | 2,20:1 | 2½, 15:1 | 2½, 15:1 | 2½, 15:1 | 2½, 20:1 |
| Tie bars: Number | 8 | 2 | 4 | 2 | 4 | 4 | 4 | 4 |
| Size, inches | 1.5 | 2 | 2.125 | 1.750 | 1.5 | 1.5 | 1.5 | 2 |
| Machine dimensions (L x W x H), feet | (7x4x6.5 (mold section. (3x1x6 control (cabinet. | 4x2.6x4.2 | 10x10x7 | 10x10x7 | 3.3x2.7x8.3 | 4.2x3.3x8.3 | 3.7x5x8.3 | 5.5x4x11 (mold mechanism) |
| | | | | | 3.5x1.3 x5.3 | 3.5x1.3 x5.3 | 3.5x1.3 x5.3 | 3.5x1.3 (control x5.3 cabinet) |
| | | | | | 5.3x2.3 x6.9 | 5.3x2.3 x6.9 | 5.3x2.3 x6.9 | 6.4x2.3 x6.9 (Extruder) |
| Approx. floor space required, sq. ft. | 31 | 12 | 100 | 100 | 48 | 56 | 63 | 92 |
| Approx. shipping weight, lbs. | 2,400 | 2,800 | 10,000 | 8,000 | 1,500 | 1,900 | 2,200 | 2,900 (mold mechanism) |
| | | | | | 385 | 385 | 385 | 385 (control cabinet) |
| | | | | | 2,290 | 2,290 | 2,290 | 2,900 (extruder) |
| Special features | Finished parts do not require reaming, etc. | All components easily accessible. Finished parts do not require reaming, etc. | Die-centering stops and parison cut-off shears not required. Air-cylinder parison strippers at each nozzle. | | Machine delivers finished parts that do not require reaming or other secondary operations. | | | |
| Optional features avail. at extra cost | Variety of screws and heads. | Valve manifolds & variety of heads. | Larger daylight & stroke for larger parts. | | Can be equipped with non-corrosive components enabling their use with rigid PVC or other corrosive materials. Multi-cavity operation. | | | |
| Approx. delivery time, weeks, after placing order | 8 | 8 | 8 | 8 | 8 - 12 | 8 - 12 | 12 - 16 | 12 - 16 |
| | *At 30 psi. air pressure. | *At 30 psi. air pressure. | *At 30 psi. air pressure. | | | | | |

♦ Complete company names and addresses are as follows:

Acme Machinery & Manufacturing Co.
for Boston Plastic Machinery Inc., 20 South Broadway, Yonkers, New York
Atlas Machine & Tool Corp., 257-259 Hackensack St., East Rutherford, N. J.
Auto-Blow Corporation, 401 Bishop Avenue, Bridgeport 10, Conn.
Barclay Industries, Inc., for Johann Fischer Co.
11 west 42nd Street, New York 36, N. Y.
Battenfeld Corporation of America, 959 west Grace St., Chicago 13, Ill.
Kautex - U. S. Sales Co., Inc., 133-10 32nd Avenue, Flushing 54, New York
Leedpak, Inc., 924 Fifth Avenue, New York, N. Y.
Moslo Machinery Company, 2443 Prospect Avenue, Cleveland 15, Ohio
The Rainville Co., Inc. for Danish Plastics Blow-O-Matic,
405 Central Avenue, Bridgeport 1, Connecticut
F. J. Stokes Corporation, 5500 Tabor Road, Philadelphia 20, Pa.
Air-Formed Products Corp., Pine Street Ext., Nashua, New Hampshire

| Manufacturer* | Battenfeld | | | | | | Kautex | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Machine name or model number | BBA 25 | BBA 60 | BEBA 3 | BEBA 10 | BEKB 10 | BEKB 50 | 38 | 50 | 1-10 | 10-100 |
| Type of preliminary operation, etc. | Injection | Injection | Extrusion | Extrusion | Extrusion | Extrusion | Extrusion | Extrusion | Extrusion | Extrusion |
| Method of operation | Auto. | Auto. | Auto. | Auto. | Auto. | Auto. | Auto. | Auto. | Semi-automatic → | |
| Number of Molds | One | One | One | One | One | One | One | One | One | One |
| Number of pieces per cycle | One | One | One | One | One | One | Multiforming possible on all models. → | | | |
| Hopper capacity, lbs. | 50 ♦ | 50 ♦ | 50 ♦ | 50 ♦ | 50 ♦ | 50 ♦ | 70 | 70 | 140 | 140 |
| Platen area, W x D, inches | 9.8x9.8 | 14x2x7.9 | 11.8x5.9 | 13.39x7.87 | 19.29x15.75 | 26.18x23.62 | 8.5x10.75 | 8.5x10.75 | 18 x 24 | 28 x 36 |
| Clamp tonnage or Mold closing force, tons. | 6 | 17 | 15 | 30 | 30 | 90 | 1.38 | 1.38 | 20.63 | 27.86 |
| Daylight opening, inches | 7.09 | - - | 9.84 | 11.81 | 11.81 | 17.72 | 13.75 | 13.75 | 36 | 44 |
| Platen stroke, inches | 5.90 | 7.88 | 7.88 | 9.84 | 9.84 | 15.75 | 11 | 11 | 34.64 | 70.87 |
| Max. size of part moldable: | | | | | | | | | | |
| Diameter, inches or W x D | - - | - - | - - | - - | - - | - - | 6.5 | 6.5 | 17.75 | 21.75 |
| Length, inches | 7.1 | 9.8 | - - | - - | - - | - - | 10.25 | 10.25 | 23.75 | 35.75 |
| Projected cross-section area, sq.in. | - - | - - | - - | - - | - - | - - | 66.63 | 66.63 | 421.56 | 779.56 |
| Dry cycle time (without cooling), minutes. | - - | - - | - - | - - | - - | - - | .033 | .033 | .029 | .029 |
| Output, lbs./hr., of finished parts (in polyethylene) | 17.6 | 26 | 44 | 88 | 55 | 110 | 50 | 66 | 132 | 164 |
| Recommended preliminary machine size, (also include L/D ratio for extruder, if used) | Vol./shot 14.76 cu. in. | Vol./shot 36.05 cu. in. | 1½, 20:1 | 2½, 24:1 | 2,20:1 | 2½, 20:1 | 1½, 15:1 | 2,13.8:1 | 2,13.8:1 (2 reqd.) | 2,13.8:1 (2 reqd.) |
| Tie bars: Number | 2 | 2 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 4 |
| Size, inches | - - | 1.97 | 1.57 | 1.97 | 1.97 | 2.56 | 1.25 | 1.25 | - - | - - |
| Machine dimensions (LxWxH), feet | 5x4.5x8.5 | 8.2x3.3x6.9 | - - | - - | - - | - - | 5x5.5x7.5 | 5x5.5x7.5 | 20x16x12 | 20x16x12 |
| Approx. floor space reqd., sq. ft. | - - | - - | - - | - - | - - | - - | 104 | 104 | 600 | 600 |
| Approx. shipping weight, lbs. | 3,600 Net 4,400 Gross | 5,512 Net | - - | - - | - - | - - | 9,300 | 9,300 | 8,000 | 9,000 |
| Special features | - - | - - | - - | - - | - - | - - | Finished parts do not require reaming or other secondary operations. Flanges on inside surface of bottle necks possible. → | | | |
| Optional features avail. at extra cost | - - | - - | - - | - - | - - | - - | Dual extrusion equipt. Variety of screws and heads and inj.-type (reservoir) head. → | | | |
| Approx. delivery time, weeks | 10 - 12 | 10 - 12 | 10 - 12 | 10 - 12 | 10 - 12 | 10 - 12 | 6 - 8 | 6 - 8 | 10 - 14 | 10 - 14 |

Note: Blank spaces denote material not submitted by manufacturer.

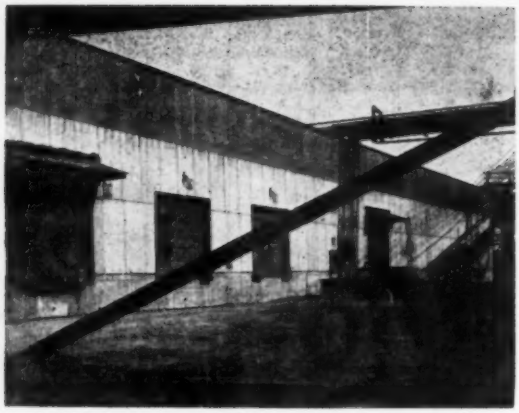
Note: Blank spaces denote material not submitted by manufacturer.

| Manufacturer* | Leedpak | Moslo | Rainville | | | | Stokes | Air-Formed |
|---|---|---|---|---|---|---|---|---|
| Machine name or model number | All-Pac | 1246 | 1/2 | 1-1/2 | 3 | 5 | #35 | A 250 |
| Type of preliminary operation, etc. | Blow-forming* | Injection | Extrusion | Extrusion | Extrusion | Extrusion | Extrusion | Extrusion |
| Method of operation | Automatic | Auto., Semi-auto. & manual. | Automatic and manual → | | | | Auto., Semi-auto. & manual. | Semi-auto. |
| Number of molds | 6 | 2 (6 cav. ea. 1 parison) | 1 or 2 | 1 or 2 | 1 or 2 | 1 or 2 | 2 | 2, 4, or 8 |
| Number of pieces per cycle | 6 | 6 | 1 or 2 | 1 or 2 | 1 or 2 | 1 or 2 | 2 or more | 2, 4, o4 8 |
| Hopper capacity, lbs. | Not applicable | 75 | 50 ♦ | 50 ♦ | 50 ♦ | 50 ♦ | 50 ♦ | 150 |
| Platen area, W x D, inches | 11 x 22 | 10.9 x 14 | 10 x 12 | - - | - - | - - | 18 x 8 | 19½ x 17 |
| Clamp tonnage or Mold closing force, tons. | 1.5 | 90 | 3.14 | - - | - - | - - | 1 | 2 |
| Daylight opening, inches | 6 | 16 | 13.5 | - - | - - | - - | 18.0 | 12 |
| Platen stroke, inches | 4 | 6 | 10 | - - | - - | - - | 8.0 | 12 |
| Max. size of part modable: | | | | | | | | |
| Diameter, inches qr W x D | 4 | 5 | 7 | - - | - - | - - | 7.75 | 11 |
| Length, inches | 11 | 10 | 30 | - - | - - | - - | 36.0 | 40 |
| Projected cross-section area, sq. in. | 44** | 50 | 210 | - - | - - | - - | 100* | 80 |
| Dry cycle time (without cooling), minutes. | .066 | .10 | .05 | .05 | .16 | .16 | .084 | .018 |
| Output, lbs./hr., of finished parts (in polyethylene) | 315 | 125 | 100 | 150 | 200 | 250 | 80 | 80 |
| Recommended preliminary machine size (also include L/D ratio for extruder, if used) | Not applicable | 4-6 oz. | 2½, 18:1 | - - | - - | - - | 2½, 20:1 | 2½, 20:1 |
| Tie bars: Number | None | None | 2 | 2 | 2 | 2 | 2 | 2 |
| Size, inches | None | None | 1.75 | 1.75 | 2 | 2 | 1.50 | 1 |
| Machine dimensions (L x W x H), feet | 11 x 4 x 4 | 8x4.6x7.6 | 5 x 3* 5 x 3** | - - | - - | - - | 8.5x3.0x5.7 | 14 x 7 x 10 |
| Approx. floor space required, sq. ft. | 44 | 45 | 30 | - - | - - | - - | 40 | 200 |
| Approx. shipping weight, lbs. | 2,500 | 15,000 | 2,000 | - - | - - | - - | 1,500 | 6,000 |
| Special features | Special laminates can be blow-formed. | Bottle sections molded to finished size uniformly. No pinch-off marks or impressions. | Finished parts do not require reaming or other secondary operations. Parisons are produced continuously permitting maximum output of extruder. → | | | | Open construction. Easy access for set-up and maintenance. | Finished parts do not require reaming, etc. |
| Optional features avail. at extra cost | None | Precompression inj. system. Inj. ram speed control. Extra tooling. | Platen carriages are interchangeable in all models & are available as spares. → | | | | Electrical safety interlocks. | Hydr. power unit. 1-lb. inj.-type crosshead nozzle. |
| Approx. delivery time, weeks | 8 - 10 | 12 - 16 | 1 week | - - | - - | - - | 4 | 16 |

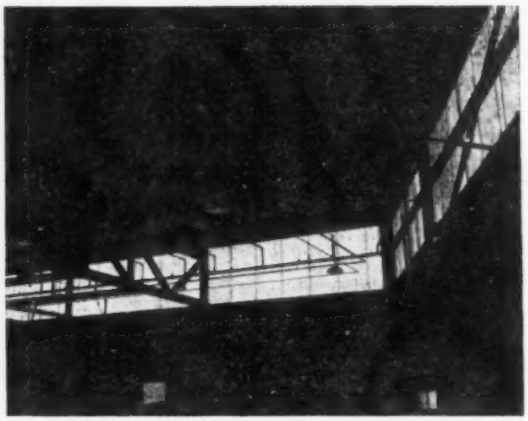
* From sheet plastic.
**At 50 psi. pressure.

* Mold mechanism.
** Control cabinet.
Note: Blank spaces denote material not submitted by manufacturer.

* At 20 psi. air pressure.



Entire upper third of Dalapon warehouse consists of joined polyester panels.



Interior shot. Note light transmission qualities.

# Styrene or Vinyltoluene in Polyester Building Panels?

SUCCESS may breed success, but it can also create problems. Take reinforced plastic building panels wherein different monomers can be used to crosslink the polyester resins. Increased demands for these panels have been accompanied by increased demands on the part of the fabricator—definitions as to how these base materials affect end product properties.

Dow Chemical Co., a supplier of glycols used in polyester manufacture and both styrene and vinyltoluene crosslinking monomers, recently completed such a study. Five polyester manufacturers — American Cyanamid, Glidden's Nubian division, Interchemical Corp., Pittsburgh Plate Glass, and Rohm & Haas—submitted base polyester alkyd resins. In addition, three variations were submitted: a blend with styrene and methylmethacrylate, a blend with methylstyrene (similar to vinyltoluene), and a light-stabilized vinyltoluene polyester.

Alsynite Co. of America, a leading fabricator, made panels on commercial equipment. Each resin was formulated with Dow Styrene RG, PL, and with vinyltoluene; recommended catalysts (usually cumene hydroperoxide and benzoyl peroxide) were used; and all panels were made with either a 4.2-inch pitch corrugation for side wall installation or a 2.5-inch pitch for installation on building monitors. Except for some panels with special surface treatment, all panels were smooth, light green in color, and had identical pigment and fiber reinforcement ratios. Thickness was 1/16-inch.

Dow installed the finished panels on the North, East, and West sides of the Dalapon building at Midland, Mich., during December 1955 and February 1956. They replaced about 7,300 square feet of corrugated asbestos cement panels used as primary wall surface. Panel sections also were exposed in Florida and rural Michigan as a cross check.

Evaluation began last Fall, and it was found that no serious failure had occurred, nor had any maintenance, repair, or cleaning been necessary. Panels were graded for fading and gloss loss, yellowing, and fiber prominence. There was a certain amount, and the vinyltoluene-polyester panels faded or yellowed slightly more than did their styrene-crosslinked counterparts. An important exception to this were the panels containing vinyltoluene and a light stabilizer. No difference in properties was noticed between the two different-styrene crosslinked panels.

The best appearing panels contained polyester resin with methylmethacrylate in addition to styrene. Panels which received special surface treatment of mat overlay plus lacquer or wax coating had distinctly improved weatherability. In conclusion, unless the processing advantages of vinyltoluene are important, styrene is completely adequate—better, in fact, unless a special light stabilizer is added to the formulation. These processing advantages are higher cure temperatures and less volatilization; therefore, faster cycling.

—THE END

*Edited by:*
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# Compression & Transfer Molding

## Introduction to Reinforced (Impact) Phenolics

ONE of the decisions that a molder must often make when designing a phenolic part is whether to increase the wall section and use low-impact phenolic or or to minimize the thickness and use a higher-impact material. This article aims to familiarize the reader with the types of reinforced phenolics available and, to some extent, their uses.

Generally, reinforced molding compounds are used for the following reasons:

(1). Inexpensive, low-impact, general-purpose materials do not give the strength or shock resistance required.

(2). Part is to compete in toughness with durable woods and metals.

(3). Weight reduction is necessary. With impacts, thinner walls, yet a stronger part, are made possible by the reinforcing filler.

(4). Machining the parts from solid laminate blocks is more expensive in the over-all than molding, plus the total tooling cost to mold. (Criterion is sufficient volume to amortize tooling).

(5). Reinforced lay-up matte molding or sheet stock molding will not conform to the design of the part.

The most common reinforcing fillers used in conjunction with molding compounds are glass fibers, cotton cord, cotton fabric or macerate, cotton fibers, sisal fibers, asbestos fibers and cord, and cotton or paper flock. Two additional fillers lending shock-resistance strength to phenolics are rubber derivatives and nylon.

A practical approach or method for determining whether a part requires reinforced thermosetting molding compounds, especially phenolics, is set up below. It should be pointed out that there is no single approach. Also, some of the points below could apply to other types of reinforced thermosetting molding compounds.

Step No. 1. The first question that comes up is whether the part is practical to mold. The question is answered by an examination of the part and the volume required. When the design is complex and lugs, bosses, or inserts must be included, the part should be molded rather than machined. The volume required should be sufficient to amortize the mold cost. It is more important to make sure that all property requirements are known.

Step No. 2. The next question that arises is whether thermoplastic or thermosetting materials should be used. The choice often centers around the final piece-part price. However, thermosetting materials should be used when the part demands maximum heat resistance, non-elongation under stress, maximum hardness, wear resistance under pressure, best dimensional stability, resistance to certain solvents, maximum scratch resistance, and resistance to cold flow.

Step No. 3. The final question evolves around the choice of the phenolic compound. Physical characteristics gained through reinforcement are impact resistance, shock resistance, increase in torque resistance, resistance to chipping, improvement of fatigue factor, improvement of crushing strength, wearability under load, and strength in thin sections. Reinforced phenolics overcome the brittleness and shatterability of low impacts.

The metals and hardwoods do enter into competition with reinforced moldings. However, when a comparison is made as to the electrical and chemical properties, weather and corrosion resistances, lower finishing costs, and some colors available from reinforced thermosetting molding compounds, they become economical, practical, and advantageous to use over hardwoods and metals.

*(Continued on page 90)*

*Edited by:*
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# Reinforced Plastics

## Advantages and Disadvantages in Fiber-Glass Boat Designs

THE general opinion of informed boat people is that fiber-glass material offers the greatest potential for pleasure and work boats construction. Its recognized chemical and mechanical characteristics make it ideally suited for this purpose. However, the design of fiber-glass boats, in most cases, has suffered from a lack of appreciation in the eyes of the buying public.

When fiber glass first was introduced to boat building a number of understandable mistakes were made. Radii often were too sharp, resulting in chipping of highly resinous edges; deck flanges were too shallow, causing breakage under stepping loads; unwise location of post-bonded attachments resulted in peel failure at points where local stresses occurred; and many other such unfortunate design factors formed a part of the growing pains of the new material in the boat field.

These difficulties were relatively easy to solve and, in most cases, were of short duration. But experience with these difficulties resulted in over-compensating reactions. Some of these reactions placed an emphasis on generous radii, one-piece constructions with integral sculpting, and excessive use of aluminum and rubber, often without due consideration of the untutored but important preferences of the boat buyer. The result is that most fiber glass boat manufacturers have overcome the "real" problems of construction: strength, safety, gel-coat surface, moldability, chemical durability, complex contours, and so forth, but have yet to achieve in their boats the maximum saleability from design standpoints.

Reinforced-plastics boat manufacturers should be aware of and be responsive to both the good and the bad in public opinion. On the good side, the public appears to be sold on the non-corrosive qualities, hull strength, and low maintenance advantages of fiber-glass boats. These qualities are great accomplishments, and certainly are powerful sales inducements over wood boats. However, these advantages must be utilized to a greater degree in sales appeal.

Listed are some of the frequent complaints expressed by the general public in rebuttal to the propounded advantages of fiber-glass boats: "It doesn't look as nice as a wooden boat." "It's cheap and flimsy looking." "It looks too much like plastic and smells bad inside." "It's probably strong, but I would rather have a regular boat." "My wife thinks plastic breaks easily."

It is interesting to note that such objections are without "real" or engineering grounds. All such reactions are based on emotional motivations, and largely are the major reasons in the case against fiber-glass boats.

Such objections can be overcome without greatly increasing the cost of the fiber-glass boat. In comparing wood and fiber-glass boats objectively, it should be remembered that wood is a familiar commodity used for centuries around the home and in boat construction. It is an accepted materail, whereas reinforced plastics are new and still breaking ground in new applications. Wood is inherently solid looking and overly sedate if not properly handled. For example, an accessory made of plastic, such as a cabin top, flying bridge, transom apron, etc., provides a refreshing and interesting modern touch to a wood boat. A rubber bumper lends a fashionable note to the boat design. On the other hand, fiber-glass can create the opposite impression if used entirely in the boat constructions without any relief.

Combine it with aluminum and rubber and the result is not as eye-appealing because of the often-cold appearance associated with these materials. However, the same fiber-glass boat trimmed with wood often achieves a softened, more inviting look.

The past decade of fiber-glass history is dotted with the appearance and demise of "ultra modern", extreme models—some with platform forward decks, some with

*(Continued on page 90)*

*Edited by:*
MAX WOHLLEBEN, *Dir. of Sales Engineering*
*Newark Die Co., Inc.*
*Newark, N. J.*

# Moldmaking & Tooling

## Another Accomplishment in Automation

EVERYONE affiliated with the Plastics Industry is very much interested in automation. The machine builder and the mold builder are working together very closely to achieve full automation in the operation of the mold and the molding machine to produce a great variety of plastics parts for the ever-increasing market. The captive and the custom molder certainly look toward the economy and savings gained in automatic production.

In the following, let us discuss a single- or multiple-cavity mold intended to run in the fairly new and truly automatic Stokes injection machines, the #701—three-ounce machine and the #703—six-ounce machine.

The mold designer must adhere to certain specifications necessary and essential for the proper alignment of the mold with the injection molding machine. The dimension from the lower press platen to the main parting line of the mold, known as the fixed dimension, is very important.

The runners also are milled into both halves or only the lower half of the mold at the main parting line, in conjunction with the proper height and the angular position of the nozzle with the built-in-shut-off pin. This unit is operated hydraulically and synchronized with the injection cylinder, permitting the advantageous pre-packing of the plastic material in the injection cylinder. This feature permits almost immediate retraction of the plunger before the plastic material in the runners and the gates is completely set-up. For proper seal-off on the nozzle and the mold proper, a supporting and adjustable screw has been provided, requiring a specially dimensioned clearance on the back side of the mold.

The mold may be designed to have either top or bottom ejector pins or both, depending on the nature of the part to be molded. The ejector mechanism is operated hydraulically and is independent of the clamping ram. Therefore, a definite determination of part ejection from either the lower or upper half of the mold must be made at the design stage to select the most advantageous condition for molding the part.

The locations of the ejector pins must be carefully studied to obtain proper ejection parallel to the draw, and should be aligned so that as many ejector pins as possible fall in one slot of the comb plate. This is true especially on a multiple-cavity mold, molding a combination of parts requiring a different position of the ejector pins for proper ejection. A 45° angular position from pin to pin very often is advantageous.

The same holds true with regard to positioning the ejector pins for the runner system.

The designer always must bear in mind that the fewer slots in any comb plate, the stronger the plate. In many cases, however, the comb plates are supported by the cavity parting line or highest projection of the male component. If maximum area for the strip-off and carry-off of molded parts and runner is gained, the wider the support.

It is worthy to note that ejection of the parts by the aforementioned comb plates is free of limitations inherent in many other machines. Parts and runners remain on the comb plates after automatic retraction of the piece or runner ejector pins, ready to be swept off the comb plates positively into the divided chute provided for them. These chutes could be arranged so the parts fall into a separate container to be carried away by a conveyer, ready for the necessary assembly operations.

Comparably, a horizontal injection machine requires positive ejection of the runner system by a stripper-actuated plate or a secondary sprue-gate ejector mech-

*(Continued on page 90)*

# PLASTICS TECHNOLOGY

## EXPLORING FABRICATION TECHNIQUES

By L. J. ZUKOR, *Engineering Editor*

### Silicone Resins . . .

. . . have attained their greatest volume of use in the electrical field as wire and cable insulations. This is not surprising, since the growing demand for more power and the need for reduced size have pushed operating requirements beyond the limits of organic elastomers. Silicone alone among the resins provides flexibility over a temperature range of —150° to +500° F. and, for short periods, will withstand a temperature of 600° F. This, combined with good insulating properties and corona and arc resistance, make it eminently suitable for use in aircraft, automotive, and power cable applications.

Since the polymer is completely inorganic, carbonized electrical paths are not formed on or through the material. This, in effect, increases resistance to corona and leakage. Even when decomposed by a flame, silicone resin forms a non-conducting ash. The ash is not self-supporting, and oftentimes a fiber-glass or asbestos sheath covering is used over the silicone so that a cable will continue to operate in an extreme emergency. Other features are: silicone-insulated cable can support up to 90% more current than ordinary cable of the same size; its thermal conductivity is higher than other elastomers, which results in a greater rate of heat dissipation and is important for cooler-operating conductors; silicone is inert, odorless, tasteless and, therefore, can be used in direct contact with foodstuffs and biologicals.

Silicone resin manufacturers, during the past few years, have been so engrossed in improving the physical properties of their compounds that little effort was expended in improving the handling and processing characteristics. It is these handling and fabricating techniques that are of greatest interest and importance to wire and cable manufacturers.

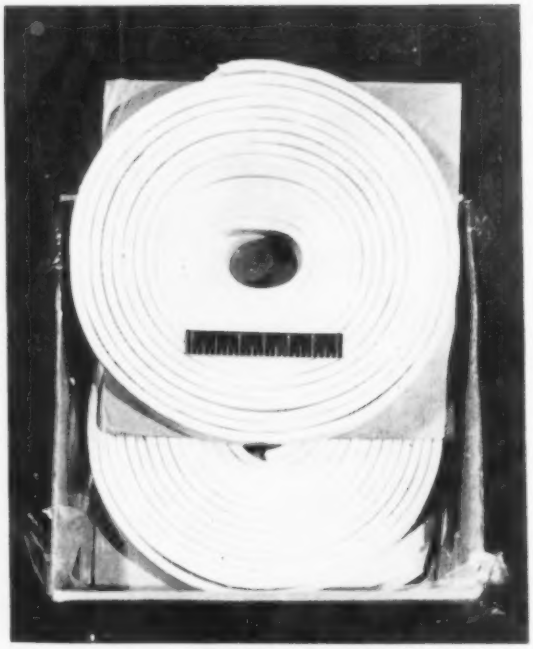

Photo Courtesy: Silicone Div., Union Carbide Corp.

Packaged Direct-Feed Silicone strip.

Photo Courtesy: Dow Corning Co.

Direct-Feed stock being fed into extruder.

Some manufacturers still adhere to the older methods and practices common to the handling of natural and synthetic rubbers. One drawback to this is that contamination always occurs (unless preceded by a heavy cleaning operation) when changing over from hydrocarbon materials to the silicones. Other manufacturers use the direct feed method, which is the procedure more closely allied to plastics operations than to rubber. Here, the wire manufacturer no longer has to mill his own material. Further, he does not have to handle and make-up the resin into the strip form needed for his extruders. Direct-feed compounds are catalized, 2 x ½-inch strips obtained from a two-roll mill with cutter attachments. These plasticized strips are lightly dusted (to prevent sticking) and coiled for shipment by the resin manufacturer. Resin manufac-

turers, among them G-E, Dow-Corning, and Union Carbide, all prepare and offer direct-feed stocks. An advantage obtained by using this form is that no modifications of the rubber-type extruders in present use are required.

The latest development in processing comes from Union Carbide, who has introduced compounds in pellet form so that the resin can be used universally in the current group of extruders being offered to the plastics and rubber industries. The company recommends a compression ratio of 2:1 when extruding either the strip or the newer pellets. Higher compression ratios have also been tried with relatively good results.

Silicones, unlike other plastic elastomers, must be post-cured or vulcanized in much the same fashion as rubbers. Therefore, it is the residence time in the curing medium (hot air or steam) that is the controlling factor in setting the speed of extrusion which, in turn, sets the production rate of finished product. Depending on the radial thickness of the resin, dwell times of 30-70 seconds in 120-160 psig. steam are recommended by Union Carbide for good cures.

Of the many wire producers, the Okonite Co., Passaic, N.J., a subsidiary of Kennecott Copper Corp., has been in production since 1946 of various types of silicone wire and cable insulations. This company, because of its long and successful operations in the rubber field, was in an excellent position to try its existing equipment in preparing all the silicone compounds as they were developed. It currently uses the direct-feed strip in the North Brunswick plant, where it also has facilities to prepare strip of its own formulation. The Passaic plant uses the pan-cure method for large diameter wire and also has facilities to use the lead-shroud method for heavy conductor sections.

For the general run of silicone-coated wire, the company favors the CV (steam vulcanization) method, rather than the HAV (hot air vulcanization) method. This is readily understandable, since more equipment and controls are necessary to keep a large volume of air circulating at high temperature than are necessary to circulate high-pressure steam.

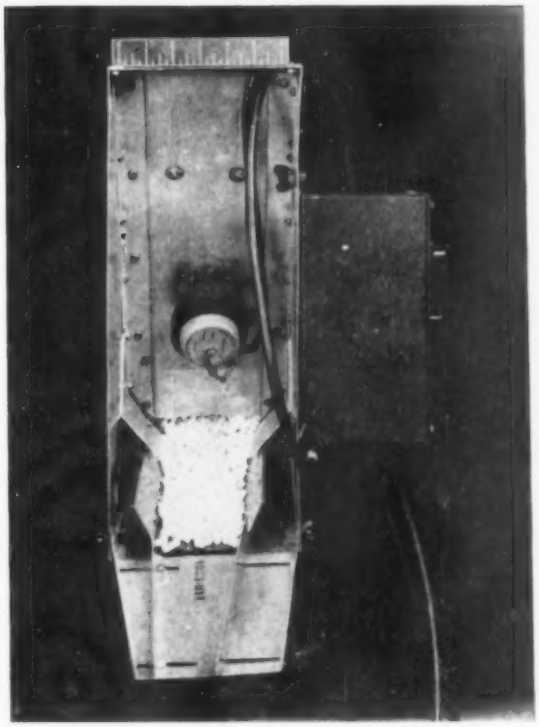

Photo Courtesy: Silicone Div., Union Carbide Corp.

Experimental Pellet Hopper—showing Syntron Vibrator in place.

Okonite has also used the pelletized resin, and has found that its present extruders with an approximate L/D ratio of 10:1 would have to be run at a lowered speed because of the low bulk density of the material. Here, it should be understood that an increased L/D ratio will tend to increase the bulk density of the resin. This, however, makes it increasingly difficult to remove the heat generated by high screw speeds. Silicone compounds used for wire insulation generally should be kept below 115° F. to prevent scorch or pre-cure. —THE END

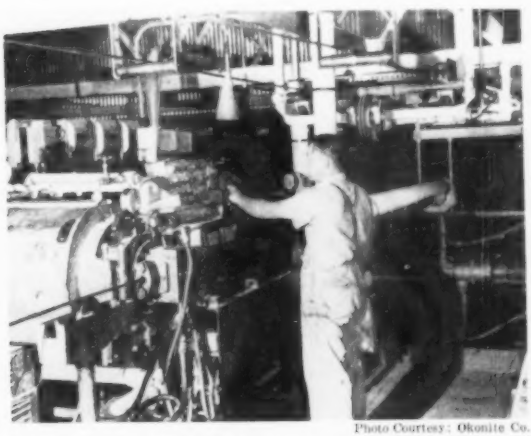

Photo Courtesy: Okonite Co.

Silicone Compound extruded in continuous vulcanizing machine. Wire speeds through the tube at 400 feet per minute or more.

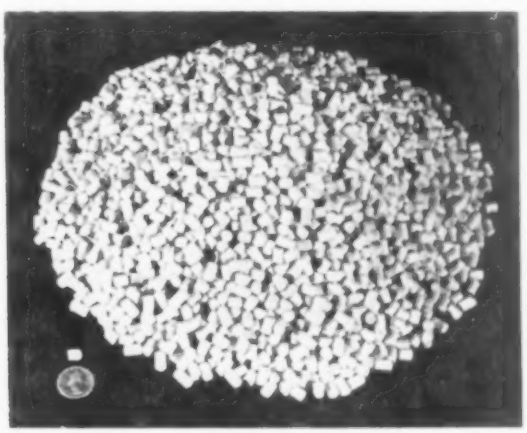

Photo Courtesy: Silicone Div., Union Carbide Corp.

Dusted Silicone Pellets.

# A NEW HERCULES PLASTIC!

**TYPICAL PROPERTIES OF HI-FAX**

| | |
|---|---|
| Crystalline melting point, °F. | 268 |
| Specific gravity | 0.945-0.947 |
| Mold shrinkage, in./in. | 0.022-0.028 |
| Water absorption, % | 0.03 |
| Heat-distortion temperature (66 p.s.i.), °F. | 144-154 |
| Deformation under 2000-lb load for 6 hr. at 122°F., % | 9-16 |
| Hardness, Rockwell R | 35-40 |
| Impact, Izod, ft.-lbs./in., notched | 1.5-12 |
| unnotched | >32 |
| Tensile yield stress at 73°F., p.s.i. | 3450-4500 |
| at 212°F. | 1300-1800 |
| Ultimate elongation at 73°F.,% | 100-700 |
| Dielectric constant | 2.33 |
| Power factor | 0.0007 |

**hi-fax®**

First of the new Hercules family of plastics, Hi-fax is the Hercules trademark for high-density polyethylene. As produced by an exclusive process, it is superior in many ways to other high-density materials. As a result, Hi-fax offers important advantages to producers in the markets where it now serves. Its superior properties, combined with the outstanding processing economies it affords, yield quality, low-cost products.

**Blown containers:** Hi-fax is now the standard material by which all plastics used in blown bottles and containers are judged. It provides outstanding performance and economy, especially in products designed to package corrosive materials, offering a high degree of stress-crack resistance coupled with lightweight strength in thin-wall sections.

**Industrial shapes:** Excellent processability, outstanding low temperature resistance, dimensional stability, and durability in long-term use are characteristic of the many industrial parts now being fabricated with Hi-fax by extrusion and injection molding.

**Wire:** Wire and cable coatings made with Hi-fax provide a toughness and resistance to abrasion superior to almost any other plastic or rubber.

**Pipe:** A special pipe grade of Hi-fax yields a low-cost, thin-wall flexible pipe, NSF approved, and setting new standards for quality in flexible piping. Extruders have found it offers many processing advantages over competitive materials.

*Flexible Pipe*

*Wire and Cable Coatings*

*Containers*

*Cosmetic Packaging*

*Detergent Bottles*

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Pro-fax, the bright new name in thermoplastics, is the Hercules trademark for polypropylene. With a high softening point, Pro-fax is dimensionally stable at temperatures as high as 300°F. It has a hard, glossy surface finish, and is available in a full range of opaque and translucent colors. With a specific gravity of only 0.9, *Pro-fax is the lightest of all plastics*, providing a production bonus of many extra parts per pound over other materials in its same price-property class.

**Pro-fax for injection molding:** Pro-fax is an excellent general-purpose material now finding broad use in such markets as closures and containers, automotive and appliance parts, valves and fittings, housewares, toys, and sporting goods. Pro-fax molds rapidly and well, has only half the shrinkage of high-density polyethylene.

**Pro-fax for extrusion:** Pro-fax monofilaments are now in growing use in rope, fish nets, seat cover fabrics, outdoor furniture webbing, bristles, pen tubes, and a variety of industrial parts. Extruded Pro-fax sheet provides a splendid structural material for vacuum-forming, thermoforming, and fabrication. Pro-fax film for packaging has sparkling clarity, outstanding toughness, and excellent resistance to permeation.

**pro-fax**®

**TYPICAL PROPERTIES OF PRO-FAX**

| | |
|---|---|
| Crystalline melting point, °F. | 333 |
| Specific gravity | 0.901 |
| Mold shrinkage, in./in. | 0.015 to 0.020 |
| Water absorption, % | 0.03 |
| Heat-distortion temperature (66 p.s.i.), °F. | 221 |
| Deformation under 2000-lb. load for 6 hr. at 122°F., % | 2.0 |
| Hardness, Rockwell R | 93 |
| Impact, Izod, ft.-lbs./in., notched | 1 |
| unnotched | >17 |
| Tensile yield stress at 73°F., p.s.i. | 4970 |
| at 212°F. | 1720 |
| Ultimate elongation at 73°F., % | >220 |
| Dielectric constant | 2.0 |
| Power factor | 0.0003 |

CP 59-10

HERCULES POWDER COMPANY
INCORPORATED
WILMINGTON 99, DELAWARE

**Compression & Transfer Molding**

*(Cont'd. from page 83)*

## Evaluating Common Reinforcing Fillers

When glass fibers are used, the heat and flame resistances of the compounds are superior to those of other fibrous reinforcing fillers. With glass fiber, immunity to fungus and bacteria is enhanced, and chemical and weather resistances are improved. In addition, the greatest dimensional stability obtainable is derived when glass fibers are employed with phenolic resins. This latter point is probably the most important factor regulating the use of glass fibers with phenolics. Tolerances to the fourth decimal place may be held. Finally, the strongest molding compounds are possible with glass fibers as fillers.

Cotton cord, cotton fabric, and cotton fibers can be grouped together, since their primary differences are in impact range. These reinforcing fillers were the original types used. They impart dependable physical properties, uniformity of impregnation, good machinability, and, in general, are considered the workhorses of the impact field.

Sisal fibers are new to the field. Their most important reason for being used is low cost. Dimensional stability has not been developed. Sisal fibers are not considered good for humid atmospheres because of the wicking action of the fibers.

Asbestos fillers are added primarily to give good strength, improve heat resistance, increase dimensional stability, and improve resistances to wear, chemicals, and water.

Nylon fillers, when in the same impact range as cord, fabric, or flock, give lower water absorption, slightly higher flexural properties, lower compressive strength, lower heat distortion, lower modulus of elasticity, and some improvement in certain electrical properties. However, control of molded shrinkage is a problem when nylon filler is used.

For specific comparisons, charts are available through various material suppliers, trade magazines, and the Society of the Plastics Industry.

In addition to reinforcing fillers, there are many enhancing fillers being added to the basic types of phenolic impacts; for instance, graphite to improve wear (as in bearings), halogen compounds (in aircraft pulleys) as flame retardants, etc. The percentage of inert fillers is always small. Thus, unlike other reinforcing molding compounds, phenolic impacts are consistent in properties and depend primarily on a constant, high percentage of reinforcing filler to give the ultimate and optimum property.

In conclusion, it should be remembered that the future of the plastics industry is dependent on the number of wisely-chosen applications of the past and the good sound engineering of the present. —THE END

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**Moldmaking & Tooling**

*(Cont'd. from page 85)*

anism built into the mold. This, of course, adds to the high mold cost. The necessary comb plates for a vertical injection machine are much less expensive and can be mounted very easily to the machine (onto the retaining rack with the respective mounting holes and standardized distance between holes—another feature known as the fixed dimension).

Another feature on the mold described above is the automatic degating of the gate inlet and part. This operation is done by a separate ejector pin or pins, depending on the number of gates in the mold, mounted on a secondary ejector and pin plate that, in turn, is actuated by a hydraulic cylinder located and fastened to the underside of the mold and sequenced with the molding cycle to compress the material for a total degating of the part from the runner. The rating and bore of the cylinder is strictly relative to the material to be molded, gate dimension, and runner size.

Still another advantage is the automatic loading of inserts. Inserts are loaded into a Cytron Hopper Feeder mounted on the side of the machine and arranged so that they fall through a transparent plastic tube onto a shuttle feeder. This feeder mechanism automatically detects the proper position of the insert, right side up, or whether the feeder plate is filled with an insert or is empty. This device is actuated by an air cylinder moving the loaded plate with the insert in proper position over the component or pin receiving the insert. Then, the insert is pressed into position firmly by a second air cylinder after retraction of the feeder plate, and all is set for the injection cycle. The operation, again, is sequenced completely and connected with a detection and alarm system in case of faulty loading of the inserts, thus preventing the possibility of mold damage. —THE END

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**Reinforced Plastics**

*(Cont'd. from page 84)*

bizarre sheer lines, and some with intricate and unusual seat-and-deck moldings. Sales-wise, the best possible fiberglass design appears to be that which provides the major advantages of a plastic boat without looking too much "like plastic". Many avenues to this end are worthy of exploration, and others worthy of immediate adoption. Radii should not be unnecessarily large. Hull sides should be stiffened. Oak or mahogany trim should be used wherever possible in preference to aluminum or rubber. Simple mahogany strips above cabin windows offer the illusion of a canvas-covered house top. Simulated wood grain, pressure-sensitive sheet may be a solution to interior appearance.

Also, mahogany and dark buff pigments should be investigated for cabin and deck moldings. Cedar-pine sprays may prove successful in combatting resin odor in cabins. "Battleship Grey" interior colors should be avoided as they are unattractive psychologically. Keel areas should be large enough to prevent excessive wind drift. Finally, hull forms should not strive to be "different" except where improved hydrodynamic characteristics are involved.

Particularly in the larger boat field, boat manufacturers who achieve the best combinations of design synthesis with fiber-glass and conventional materials will obtain the biggest share of the sales. —THE END

*Antiques are fine...in museums*

# Your plant needs modern* equipment

Antiques can be expensive—particularly in the production line. Figure it out! What does it cost you to operate with obsolete equipment? The costs of down time...the costs of maintenance...the costs of low productivity...the costs of rejects due to poor quality control—can you afford the luxury of obsolete equipment costs?

Profit conscious managements have begun their plant modernization. Let us help you reduce costs and retain your competitive advantage with the advanced "Century Series Extruders." For complete information on these extruders and **a full line of modern accessory equipment,** describe your needs to Mr. Fred Maywald.

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Rua do Ouvidor, 90—8th floor,
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**ARGENTINA**
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59-1

# NEWS of the Industry

## organizational changes

**Fluorocarbon Products, Inc.**, ceased to operate as an entity on July 1 and became a production department of the parent **Garlock Packing Co.** Products will now be sold as Garlock Electronic products under the jurisdiction of the marketing division's general sales department.

**Celanese Corp. of America** has organized three new companies to administer the manufacture and sale of fibers, chemicals, and plastics: **Celanese Fibers Co., Celanese Chemical Co., and Celanese Plastics Co.** They will operate as divisions of the parent firm, and will have more distinct and autonomous identities. J. W. Brooks is president of the fibers company and R. W. KixMiller becomes president of the other two firms.

## an american plastics institute

**An American Plastics Institute** is presently in the works. A cooperative affair, it will conduct studies for the benefit of all. Typical projects will include fundamental characterization of all polymers, establishment of relationships between structure and physical behavior, evaluation of mold making methods, and fundamental molding and extrusion studies. Any suggestions and views should be directed to committee chairman, Ralph L. Mondano, Raytheon Co., Box 25, Maynard, Mass.

## shows, fairs & exhibitions

**The International Trade Fair** in Dusseldorf, W. Germany, October 17-25, can be reached by air at bargain-basement costs. Round trip fare should run about $325, complete with German-speaking interpreters on board. For full details, contact George Ventz, Atlas Machine & Tool Corp., 257 Hackensack St., E. Rutherford, N. J.; or Dr. Heinz Neunteufel, Harte & Co., 16 E. 34th St., New York City.

**The National Metal Congress** will be held at Chicago's Morrison Hotel on November 2-5. Papers on plastics and ceramics will constitute an important phase of a symposium sponsored by the Metallurgical Society Technical Committee on Chemistry and Physics of Metals.

## new plants, labs & additions

**American Cyanamid Co.** has opened a new maleic anhydride plant at Bridgeville, Pa. Initial production will be 14-million pounds, which will be increased to 20-million by next year. The installation covers two acres and constitutes part of the company's plastics & resins production facilities. Components include a warehouse, control lab, instrument center, and purification and converter section.

**A. Schulman, Inc.**, Akron, O., plans to erect a reprocessing plant at Orange, Tex. The firm currently handles polyethylene, polystyrene, vinyl, and other thermoplastics. Paul Wysynski will manage the new plant, supervising 50 employes who will work on a three-shift basis.

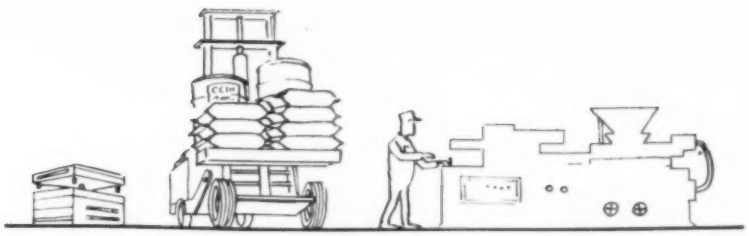
**Aeroplastic Corp.**, custom molders of expandable polystyrene, is moving to new quarters in Venice, Calif. The old plant was in El Segundo. Now nearing completion, the new facility is a one-story, 12,000 square-foot building located on a five-acre plot.

**American Chemical Corp.** has contracted with Scientific Design Co. for the design and construction of a vinyl chloride polymer plant at Watson, Calif. Completion of the unit is scheduled for mid-1960, it being the last of four completely integrated units which will total $7.5-million in cost. Location is 2112 East 223rd St., Long Beach (Watson), Calif.

**Beetle Plastics Corp.**, a subsidiary of **Crompton & Knowles Corp.**, has erected a plant in Fall River, Mass., for the production of reinforced and structural plastics. Containing over 43,000 square feet of manufacturing space, it is equipped to handle assemblies of great size such as corrosion-resistant tanks.

**Borden Chemical Co.** has completed an expansion program at its Compton (Los Angeles) plant, and has begun the installation of manufacturing equipment. The project should be completed by the end of the year, and the plant will extrude vinyl garden hose.

**Carlon Products Corp.** has expanded its plastics pipe producing facilities at Aurora, O. The firm's multi-million facilities were completed just last year, and the new addition should run about $100,000.



**Cadillac Plastic & Chemical Co.** has opened a new sales office at 54 West 30th St., Indianapolis, Ind. The firm also plans to expand its production of Cadco cast acrylic rods and extruded sheet by 40%. New facilities have been set up at the Warren, Mich., plant.

**Calcium Products division,** Georgia Marble Co., has opened a sixth calcium carbonate plant, located near Atlanta, Ga. The $100,000 unit will produce Wingdale White, a product formerly produced only at the Wingdale, N. Y., plant.

**Colton Chemical Co.,** division of Air Reduction Co., Inc., has begun expanding its production and storage facilities at Elkton, Md. A multi-million pound ester plant, warehouse, and bulk storage tanks are being added, with completion scheduled for late this year. Products of the new plant include dibutyl maleate, dibutyl phthalate, and other esters used in polyvinyl acetate and copolymer resin emulsions.

**Dewey & Almy division,** W. R. Grace & Co., has nearly completed construction of a Polyfibron lab with fully-integrated pilot scale facilities for making, impregnating, and coating papers. Location of the facility is Cambridge, Mass.

**E. I. du Pont de Nemours & Co., Inc.,** has announced plans to produce polyethylene at its plant in Victoria, Tex. Scheduled for completion by early 1961, the facility will be Du Pont's second polyethylene plant and will employ 100.

**Emery Industries, Inc.,** has scheduled a $6-million expansion of its plant in Cincinnati, O. The present unit is the world's only installation for commercial oxidation by ozonalysis. Not only will azelaic and pelargonic acid production be increased, but the firm's capacity for producing plasticizers and diesters.

**Formica Corp.** has begun the construction of a research and product development lab at Evendale, O., site of its main manufacturing plant. The new facility will consolidate all of Formica's R&D activity (except basic research), and will increase it by 40%. The lab building will cover 30,000 square feet, and will house 80 technical personnel.

**J. P. Frank Chemical Corp.** plans to increase its PVC, vinyl stearate, and vinyl acetate copolymer polymerization facilities by approximately ⅓. The Brooklyn firm also manufactures plasticizers, stabilizers, and chelators.

**Protective Coatings Corp.,** Clifton, N. J., a converter of flexible packaging materials has expanded into the extrusion coating field with the installation of a new **Egan** 4½-inch extruder. The unit can handle widths to 72 inches, and is capable of coating or laminating paper, foil, film, or paperboard with either polyethylene or nylon.

**The Vinyl Foam division,** Union Carbide Plastics Co., has moved to new quarters at 796 Frelinghuysen Ave., Newark 12, N. J. The old address was 212 Wright St.

## agents, distributors, agreements

**D. H. Littler Co., Inc.,** New York City, has been appointed sales agent for **Union Carbide Plastics Co.**—to the protective coatings industry. We reported this fact in our July issue, but inadvertently reversed the initials D. H. Our apologies.

**Hooker Chemical Corp.** has signed a license agreement with **General Electric Co.** permitting use of HET anhydride in the cure of epoxy resins under GE patent 2,744,845. Hooker customers automatically are granted a sublicense to harden epoxies thusly.

**Pacific Coast Chemicals Co.** has been named exclusive distributor of **J. M. Huber Corp.'s** kaolin clay extenders and Zeolex silicate pigments in Northern California. Main offices of the firm are at 2060 Third St., Berkeley, Calif.

**United States Rubber Co.** has licensed **Ford Motor Co.** to use a method for continuously laminating decorative vinyl sheet to metal (the Marvibond process). This is the first automotive company to use the technique, and the laminate can be found throughout the 1959 Thunderbird interior.

# Names in the News

J. Joseph Kelly

Francis V. Duffy

**J. Joseph Kelly,** who recently joined Foster Grant Co., Inc., Leominster, Mass., as marketing director, has been named general manager of the company's newly created plastics sales division. Mr. Kelly formerly was with Package Machinery Co. Other appointments include: **John W. LaBelle,** executive assistant to the executive vice president; **Francis V. Duffy,** field sales manager of the new division; and **James H. Barry,** sales service manager.

John W. LaBelle

**P. Allen Van Amburg** has been chosen general manager of Resin Formulators, Inc., Los Angeles manufacturer of epoxy resin compounds and other products for laminating and coating. He was formerly in sales promotion at Procter & Gamble.

**Leon W. Miller,** director of chemical sales for the plastics and coal chemicals division, Allied Chemical Corp., has been elected to the board of directors of the New York Board of Trade.

George C. Kroening

**George C. Kroening,** a director of Northern Plastics Corp., has been named vice president in charge of sales for the LaCrosse, Wis., firm. Since 1950, Mr. Kroening has been conducting his own business as a manufacturer's representative. He will now head the national sales organization of Northern Plastics and its subsidiary, Norplex Fabricators, Inc.

**Charles M. Standart,** assistant chief engineer, Becco Chemical Division, Food Machinery and Chemical Corp., has been promoted to chief engineer. He succeeds **James N. Vermilya,** who is retiring, but will continue as part-time consultant for FMC's international division.

Earl Erdman

**Earl Erdman** has been named group leader for Taylor Fibre Co.'s resins research section. He will be responsible for evaluation and development of new resins useful in laminated plastic products. Mr. Erdman had been chief chemist at Synvar Corp.

**J. H. Saunders,** assistant director of research for Mobay Chemical Co., has been promoted to director of research, succeeding **E. E. Hardy.** Dr. Hardy has joined Monsanto Chemical Co.'s plastics division in Springfield, Mass., where he will be an associate in the development department which is responsible for immediate and long range growth plans for new products and markets. Both men have been with Mobay since 1954.

**Robert S. Roseman** has been appointed manager of Plax Corp.'s Stonington plant. He had been manufacturing superintendent at Plax's Deep River, Conn., plant. He replaces the late **Clarence W. Coe.**

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NARROW BAND HEATERS
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1384 Ferguson Avenue
St. Louis 14, Missouri

# New Materials

*Write item numbers on Readers' Service Card (p. 123) to obtain more information.*

## Polyethylene Pipe Compound

A high-density polyethylene compound specially formulated for extruding pipe has been placed on the market by Hercules Powder Co. Called Hi-fax 1700E Pipe Black, it is said to save 36% in material over low-density polyethylene when designed for a working stress level of 600 psi.

When operated at the above stress level, Hi-fax pipe will expand not more than 2% even after 1,000,000 hours' service. No special equipment is required to manufacture Hi-fax pipe, which is approved for portable water service by NSF.

*Readers' Service Item 1*

## Epoxy Potting Compounds

Cepox potting compounds, made by Chemical Development Corp., are low-viscosity epoxy liquids useful for potting or encapsulating electrical or electronic equipment for protection against moisture, solvents, mechanical shock, and temperature changes. Cepox 501, a rigid impregnating compound, is recommended for potting coils, armatures, starters, or transformers. Cepox 502 has high impact resistance, and is particularly suitable for applications which involve temperature cycling and high mechanical shocks.

The exact amount of hardener is supplied with each package. Physical characteristics include:

| | 501 | 502 |
|---|---|---|
| Working life at 77° F., hrs. | 3 | 2 |
| Cure schedule for optimum properties, | | |
| Room temperature, hrs. | 24 | 24 |
| 150° F., hrs. | 2 | 2 |
| Shrinkage in /in. | 0.001 | 0.001 |
| Dielectric strength, volts/mil | 500 | 430 |
| Volume resistivity, ohm-cm | $8\times10^{13}$ | $10^{13}$ |
| Surface resistivity, ohms | $5.9\times10^{12}$ | $10^{12}$ |
| Dielectric constant, | | |
| Frequency 600 cps | 4.0 | 4.4 |
| Frequency $10^6$ cps | 3.8 | 3.88 |
| Dissipation factor 60 cycles | 0.031 | 0.030 |
| $10^6$ cycles | 0.017 | 0.027 |
| Loss factor 60 cycles | 0.124 | 0.132 |
| $10^6$ cycles | 0.065 | 0.100 |

*Readers' Service Item 2*

## U. H. F. Insulation Material

Rexolite #1422, a rigid cross-linked styrene copolymer, reportedly surpasses other plastics in heat resistance, machinability, and electrical properties. Rexolite #2200, a glass fiber reinforced plastic of the same cross-linked copolymer, and copper clad Rexolite #2200 are the two other members of the series. These materials are products of Rex Corp.

Under the right conditions, Rexolite #1422 may be machined, drilled, or tapped to close tolerances. With a sacrifice in electrical properties, Rexolite #2200 adds the properties of good punchability and impact strength. Neither material will cold flow.

Rexolite is now being used for prototype microwave components, and is recommended for applications where the finished article must withstand considerable strains and abuse. Its chemical inertness (unaffected by mineral acids, alkalies, alcohols, aliphatic hydrocarbons, and mineral oils) recommends it for use as inspection windows on machinery and chemical equipment, rollers for plating tanks, or electrode supports.

Rexolite #1422 can be purchased in sheets or rods; #2200, in copper clad sheets with one or two ounce copper on either or both sides. Typical properties of #1422 follow:

| | |
|---|---|
| Specific gravity | 1.045–1.050 |
| Tensile strength, psi | 7,000–9,000 |
| Flexural strength, psi | 14,000–16,000 |
| Modulus of elasticity in flexure, psi | $4.2–4.3\times10^5$ |
| Compressive strength, psi | 14,000–15,000 |
| Impact strength, Izod, ft. lbs./in. of notch | 0.3–0.4 |
| Hardness, Rockwell H | 67–68 |
| Hardness, Rockwell M | 85–89 |
| Coefficient of linear thermal expansion, cm./cm./° C. | $6.0–7.6\times10^{-5}$ |
| Water absorption, % | 0.05 |
| Thermal conductivity cal./sec. sq. cm./° C./cm. | .00035 |
| Dielectric constant, cps | $2.55–10^{3}–10^{10}$ |
| Volume resistivity, ohm/cm | $1\times10^{16}$ |
| Surface resistivity, ohms | $1\times10^{13}$ |
| Dielectric strength, volts/mil (step by step perpendicular to surface) | 700 |
| Power factor | 0.0006–0.0009 |

*Readers' Service Item 3*

## Rigid Urethane Foams

According to Allied Chemical's National Aniline Division, the thermal insulating efficiency of rigid urethane foams is nearly doubled and material costs are substantially reduced through the use of Genetron 11 (trichloromonofluoromethane) as the blowing agent. The insulating value of these foams is highest at about 1.7 lbs/cu. ft., and then decreases with decreasing densities. A small loss of insulating properties takes place upon aging foams, but the ultimate insulating value is reportedly higher than that obtained with carbon dioxide as a blowing agent.

Other advantages claimed for Genetron

SIZE? SHAPE? MATERIAL?
ALL BIPEL PREFORMS ARE BETTER!
You get more uniform density, weight and preheat with BIPEL-made preforms. Powders are formed with a controlled hydraulic, horizontal squeeze, not a tool-jarring mechanical blow. More accurate preforming of difficult powders, too . . . with safe discharge directly into tote boxes unattended. Four models, with variable pressure ranges from 13 to 155 tons, for preforms up to 6 lbs. . . . and up to 25,000 per hour!
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BIPEL
COMPRESSION-TRANSFER PRESSES
HORIZONTAL HYDRAULIC PREFORMERS

11 are low viscosity, and longer time for mixing and pouring, which facilitates mixing the reactants and heat absorption during volatization.

Genetron is a non-toxic, non-flammable liquid which boils at 74.7° F. (23.8° C.). The vapor pressure at 70° F. is 13.4 psia. It may be added to Nacconate 1080-H or, if continuous mixing equipment is used, be run as a third stream through a separate line to the mixing head.

*Readers' Service Item 4*

## Polyethylene Molding Material

Union Carbide's DPDA-7365 is a polyethylene injection molding material offering excellent low temperature properties, a high order of rigidity, good stress resistance, moldability, and gloss. Especially recommended for outdoor garbage cans, it may also be used for dishpans, toys, baby baths, and other housewares. Typical physical properties of DPDA-6365 are:

| | |
|---|---|
| Melt index, g./10 min. | 8 |
| Density, g./cc. at 23° C. | 0.945 |
| Secant modulus, psi | 40,000 |
| Tensile strength, psi | 1,600 |
| Elongation, % | 210 |
| Yield strength, psi | 1,500 |
| Brittle temperature, ° C. | |
| 50% OK | −70 |
| 80% OK | −60 |
| Stress cracking resistance | |
| 50% failures, hrs. | >336 |
| Mechanical flex life, # flexes | 200,000 |

*Readers' Service Item 5*

## Polyester Potting Resin

Vibrin X-1088-B, a clear, light amber, promoter polyester resin of the styrene type produced by Naugatuck Chemical division of U. S. Rubber Co., is recommended for use in potting and in curing large resinous masses. Infinitely compatible with styrene, the resin requires merely the addition of a catalyst like tertiary butyl hydroperoxide for many applications. It may be compounded with low cost inert fillers such as talc, asbestos, or mica.

As gelation of the resin is accelerated by light and heat, it should be stored, either catalyzed or uncatalyzed, in dark or opaque containers. Refrigeration is recommended for a storage of more than six months.

Properties of the uncured resin are:

| | |
|---|---|
| Acid number | 45 |
| Viscosity, poise, | 6 |
| Specific gravity | 1.04 |
| SPI gel test, 1% benzoyl peroxide, 180° F. bath | |
| Gel time, sec., 150-190° F. | 345 |
| Time to peak, sec., 150° F. | 585 |
| Peak exotherm, °F. | 360 |

Typical properties of the cured resin are:

| | |
|---|---|
| Specific gravity | 1.12 |
| ASTM water absorption, 24 hrs. % | 0.20 |
| Tensile strength, psi | 7300 |
| Elongation, % | 2 |
| ASTM heat distortion, °C | 90 |
| Rockwell hardness, L scale | 112 |
| M scale | 95 |
| Barcol hardness | 30 |

*Readers' Service Item 6*

## Polyethylene Coating

A grease resistant coating for board and paper products consists of equal parts of A-C polyethylene 6 and Bakelite DYLT. Developed by Allied Chemical's Semet-Solvay Petrochemical division, this low molecular weight blend is reported to have performance characteristics equal in many cases to laminations.

The coating can be applied on a reverse roll coater. Tests show a one-mil coating (13.7 pounds of resin per 3,000 sq. ft.) to be most satisfactory.

Typical properties of the blend follow:

| | |
|---|---|
| Average molecular weight | 7,000 |
| Melting point, approximate, ° F. | 221 |
| Density | 0.92 |
| Viscosity, cps., at 300° F. | 7,100 |

*Readers' Service Item 7*


**GREASELESS! SMEARLESS!**

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**A NEW ANTI-STATIC SPRAY GUARANTEED TO BE EFFECTIVE!**

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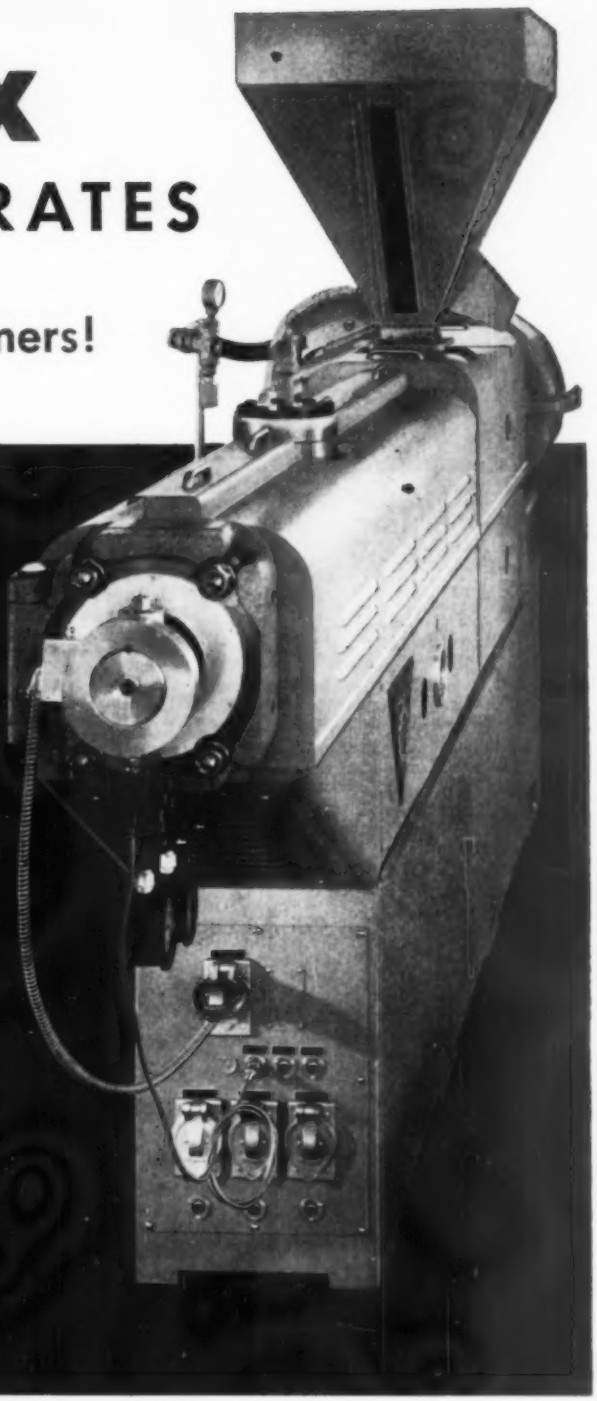
# PRODEX
# PRODUCTION RATES

## ...as reported by customers!

| 1¾" (10 H.P.) | lbs/hr. |
|---|---|
| Vinyl tubing from dryblend | 120 |
| Linear Polyethylene monofilament | 100 |
| Polyethylene blown bottles | 110 |
| 2½" (20 H.P.) | |
| ABS Sheet, vented | 200 |
| Rigid vinyl pipe from dryblend | 170 |
| Polyethylene on cellophane | 170 |
| 3½" (40 H.P.) | |
| Vinyl garden hose | 480 |
| Polyethylene pipe | 380 |
| Roll cast polypropylene film | 370 |
| 4½" (60 H.P.) | |
| High impact polystyrene sheet, vented | 670 |
| Cellulose butyrate sheet, vented | 640 |
| Vinyl coated on wire | 690 |

Proportionately high output rates are obtained on our 6" and 8" extruders



PRODEX EXTRUDERS and EXTRUSION SYSTEMS feature the most advanced developments in extrusion technology. They make profitable operations possible under the most competitive conditions. Higher outputs, faster start-ups, better uniformity, closer tolerances and less maintenance requirements are production proven facts.

PRODEX EXTRUDERS are available either **vented or non-vented with valving**...and with **L/D ratios of 20:1 —24:1 and longer.** All deliver **higher screw speeds** with **higher horsepower efficiency.**

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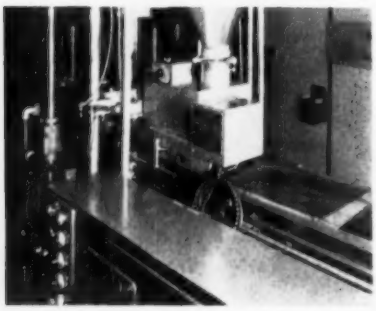
# New Equipment

*Write item numbers on Readers' Service Card (p. 123) to obtain more information.*



Stokes infra-red preheating device is interchangeable with the Model 741 standard feed hopper.

## Infra-Red Preheating Device

Curing times can be reduced 15-20% in many instances with the new Stokes Model 741 press pre-heater attachment. This device combines infra-red heating and agitation of the powder within the feed hopper. It is completely interchangeable with the standard hopper on the Model 741, and is a self-contained unit.

Parts include two 500-watt, 110-volt infra-red lamps and a 1/20 hp., 110-volt, single-phase, 60-cycle agitator motor. A heat control is provided with settings of 250-watt, 500-watt, or 1,000-watt heat delivery. The relative position of the heat source with respect to the molding material provides still another control of heat input.

Actually, the pre-heater is not intended as a substitute for high-frequency electronic preheating attachments. It offers instead, a simple and dependable method of reducing cure cycles for a modest investment. Stokes Model 741s come in 50-, 75-, 125-, and 150-ton capacities.

*Readers' Service Item 21*

## Pressure Reducing Valve

The OPW-Jordan sliding gate, pilot-operated, pressure reducing valve has been designed to overcome the weakness of globe type regulator valves by providing minimum maintenance, tight shut-off, and more accurate regulation. The valve operates thusly: as pressure is applied, line fluid media pressure flows through the inlet pilot tube to the opened pilot valve, passing the chamber above the main diaphragm, thus forcing the diaphragm downward and opening the orifices. As the pressure enters the downstream side, it is transmitted upward to the lower side of the main diaphragm, and through the outlet pilot duct to the lower side of the pilot diaphragm. Pilot diaphragm movement is resisted by the adjusting spring tension, which determines the outlet pressure. Movement of the pilot diaphragm modulates the pilot valve, controlling line pressure admitted to load the top of the main diaphragm.

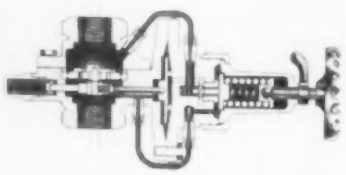
The valve is opened, closed, and modulated by an up-and-down sliding valve. When the orifices in the gate coincide with the orifices in the orifice plate, the valve is open. The gate is actuated by pressure exerted on the diaphragm. Both gate and plate are constantly in contact, and the control point is varied by the amount of pressure on the spring. Gate and plate are made of hardened stainless steel with a minimum hardness differential of 40 Brinell.

Maximum inlet pressure (steam service) on the cast iron constructed valve is 125 psi.; on the bronze and monel, 250 psi.; and on the aluminum, 50 psi.

With cold non-shock services, higher pressures may be suitable.

Dimensions of the valves in inches are:

| Size | ½ | ¾ | 1 | 1¼ | 1½ | 2 |
|---|---|---|---|---|---|---|
| Face to face | 3¾ | 3¾ | 4⅛ | 4⅛ | 4½ | 4½ |
| Center line to max. ht. | 10⅜ | 10⅜ | 10⅝ | 10⅝ | 11 | 11⅛ |
| Center line to bottom | 3 | 3 | 3⅜ | 3⅜ | 3½ | 3⅝ |
| Maximum width | 5⅞ | 5⅞ | 5⅞ | 5⅞ | 5⅞ | 5⅞ |
| Weight, lbs. | 14 | 15 | 17 | 18 | 20 | 22 |



OPW-Jordan piloted pressure regulator.

*Readers' Service Item 22*

## Temperature Control Device

A single-zone temperature control unit, the Sterlco Model 6016, has been placed on the market by Sterling, Inc. Compact and portable, the device is designed to provide exacting control of temperatures automatically at any desired pre-set from 100-550° F. (current limitation of available heat transfer fluids). Automatic or manual cooling controls are also available.

Model 6016 stands 60½ inches high, is 19½ inches wide, and measures 29¼ inches from front to back. All control circuits are 110 volts; however, users must specify whether units are to be connected for 3/60/220 or 3/60/440 power supply. Approximate current ratings with 12-kw. heaters are 35 amperes for the former power supply, 17.5 for the latter.

Sterlco Model 6016 temperature controller.

Shipping weight is about 650 pounds. As an added advantage, three units can be assembled on a single base to provide three-zone temperature control.

*Readers' Service Item 23*

## Light Scattering Photometer

A photometer for studying high-molecular-weight compounds, determining of particle sizes in the micron and sub-micron ranges, and recording of haze and turbidity in moving streams of liquid has been introduced by American Instrument Co. Specific applications include the measurement of droplet sizes of aerosols, minute imperfections in plastic and glass, and contamination of hydraulic fluids.

choice of single or dual hand levers, elec- capacities, with four different frames.

The photometer passes a light beam of uniform irradiance through the sample in solution. Resultant light-scattering is measured and applied to known values for proper evaluation. The complete instrument consists of a mercury-vapor lamp, optical unit, lamp stabilizer ballast, photomultiplier photometer, square turbidity cell, and dissymmetry cell. The largest part, the optical unit shown on the left in the accompanying photograph, measures 34½ inches long by 14¾ inches wide, and is 12 inches high.

The incident optical system produces a

American Instrument's Photometer assembly.

beam of uniform irradiance 22 mm. high by 10 mm. wide at sample cell. Beam collimation (angle between extreme rays) is 5.8° vertical by 2.6° horizontal. The receiver optical system collects total flux through a double convex lens in incident beam at 0° when two-position stop is up. This provides greater resolution than simple slit system during scattering measurements.

*Readers' Service Item 24*

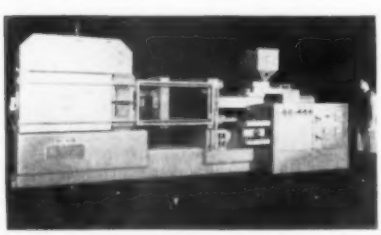
## 1,000-Cycle Injection Press

Hydraulic Press Mfg. Co. has available what is claimed to be the fastest 12/16 ounce injection molding machine, the Model 350-HV-12/16. At full clamp stroke with maximum tonnage, the unit is capable of 600 cycles per hour—1,000, with reduced strokes.

The 350-ton machine has a 60-hp. system with full hydraulic clamp, 22-inch stroke, and 34 inches between platens (42 inches with ejector box removed). The platens measure 34 by 34 inches and accomodate mold bases up to 20 by 34 inches, either vertically or horizontally. There are 20½ inches between the tie rods.

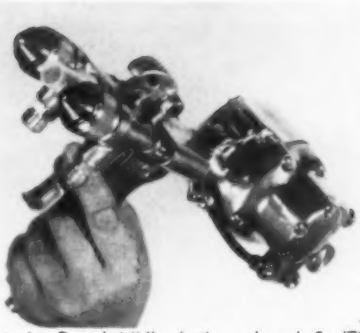
The knockout bar exerts 20 tons of pressure and has a four-inch stroke. This bar can operate either vertically or horizontally. Automatic clamp slow-down prior to bar contact prevents damage to ejected parts. The clamp automatically adjusts for different mold thicknesses and any part of the total ram stroke can be used.

Independent clamp and injection controls allow simultaneous traversing of both clamp and injection rams. This eliminates "dead time" inherent in machines using single circuits with a diverting system. A differential circuit allows rapid prepositioning of the injection plunger. The entire injection assembly is hydraulically operated and mounted on phenolic shoes in guided ways. The nozzle is held on the sprue bushing to retract the injection unit for purging or removal of the heating chamber.



HPM Model 350-HV-12/16 injection molder.

*Readers' Service Item 25*



Archer-Danie's-Midland three barrel SealZit gun, designed for reinforced plastics, sprays resins of equal viscosity through two outer barrels and glass fiber or aggregates through a central one.

## Plastics Spray System

The SealZit spray system, now available from Archer-Daniels-Midland, can be used in almost any plastics construction and maintenance job. The system, whose operation does not require extensive technical training, consists of a gun, two standard pressure pots, hoses, and pressure gages.

The three-barrel gun is designed for reinforced plastics, using resins such as epoxies, urethanes, and polyesters. Through a venturi air tube, located between the two barrels, are fed continuous glass roving or chopped lengths of ¼ to 3 inches (the system includes a rotary cutter), as well as aggregates such as sand, crushed rock, vermiculite, sawdust, expanded styrene beads, roofing granules, metallic powders, and decorative flakes. The two-barrel gun is used for non-reinforced applications.

The gun is fed from two pressure pots containing resins of equal viscosity. A catalyst is added to one pot, and an accelerator (preaccelerated resins should not be used) to the other. By thoroughly mixing the resins during application, the gun eliminates problems of metering, short pot life, and uncertain dry time. The pressure pots, hoses, and fittings are color coded for identification. However, non-interchangeable fittings are suggested for assurance against cross-connection, which "freezes" hoses and gun.

The fluid system is controlled by viscosity and air pressure. Compressed air requirements of the gun require a 5-hp. electric or 7½-hp. gasoline compressor with a delivery rate of 20 cubic feet per minute.

Savings claimed for the gun include labor costs, material costs (involves less than 5% glass waste), rejects (even resin content and no air bubbles), and construction costs.

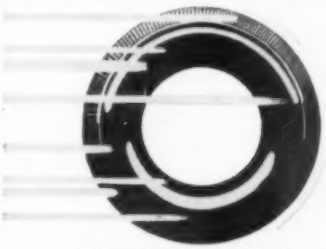
The gun is recommended for such diversified applications as boat hulls and parts, car bodies, factory maintenance, architectural structural and decorative members, protective coatings for petroleum tanks and pipelines, electronic and thermal insulation, and foams.

*Reader's Service Item 26*


COLLOID CORNER

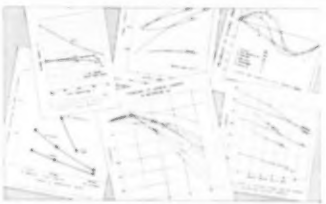
SEPTILLIONS IN THE HAND

...your hand can hold one septillion (a trillion trillions) Columbian colloidal carbon particles. A bead no larger than the period at the end of that sentence can contain 4,300,000,000,000 particles of uniform size and characteristics!



MILLION DOLLAR IDEAS

for the use of these minute particles include the strengthening of rubber. Some kind of phenomenon (not chemical reaction) causes reinforcement... adds great strength and wearability.



MULTIFOLD CHARACTERISTICS

result from sizes as small as 7 millimicrons. Take surface area, for example: One pound has the surface area of 30 acres. Or electrical conductivity: There are enough "electrical circuits" in a cubic inch of colloidal carbon to circle the world 10 times.

Columbian carbons—and iron oxides, too—of such small uniform size and pre-determined surface characteristics may have important uses in *your* industry. Write... tell us your area of interest.

COLUMBIAN CARBON COMPANY

380 Madison Ave., New York 17, N. Y.

DEPT. A

# KAUTEX

## DO YOU KNOW THAT

- KAUTEX have developed the most perfect blowing method?
- KAUTEX own over 50 patents in more than 20 countries and have filed more than 100 patent applications in this special field?
- KAUTEX have been copied by many firms all over the world who will now have to face legal proceedings?
- KAUTEX' clients acquire with the machine unlimited technical and productional advice based on 25 years' experience in the manufacture of plastics?
- KAUTEX also supply heavy-duty Blowing Machines for large size containers, barrels, tanks, etc.?

## ARE YOU AWARE that KAUTEX BLOW-MOULDING MACHINES

- provide fully automatic, continuous production?
- need no post-processing?
- produce completely finished articles which can be packed at the machine?
- require but ONE MOULD?
- permit the manufacture of small-sized articles down to 0.03 oz. with tubular openings?
- are most appropriate for blowing special articles, e.g. industrial parts, pharmaceutical flasks, toys, etc.?

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DOWNING STREET, FLUSHING 54, N.Y.
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October 17 through October 25, 1959
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**KAUTEX-WERK** REINOLD HAGEN · HANGELAR/SIEGBURG, GERMANY
Telephone: Bonn 41075 / 41841 Telex: 0886627

# Plastics Applications

*Write item numbers on Readers' Service Card (p. 123) to obtain more information.*

## Coated Cotton Fabric

Duro-Suede, a coated cotton fabric resembling suede in texture and appearance, is being manufactured by the Graniteville Co. It is a cotton material that is knife-coated with a compound based on Pliovic AO, a vinyl chloride copolymer dispersion resin produced by Goodyear Tire & Rubber Co. This resin was selected because of its low fusing temperature, plasticizer compatibility, viscosity characteristics, and film texture.

Possible uses for the materials are work gloves, work shirts and jackets, and protective elbow and knee patches.

Duro-Suede work gloves.

*Readers' Service Item 41*

## Vacuum-free Nursing Bottle

Fortiflex nursing bottles, with valves on the bottom to relieve automatically the vacuum caused by sucking action, are being manufactured by No-Vac Corp. The manufacturer claims that this design prevents an infant from getting colic from nursing a mixture of air and milk. It ensures that the nipple will not collapse and interfere with the milk intake. Available in six colors, the bottles will withstand sterilization temperatures, and can be dropped without damage. The plastic used, Fortiflex, is a high-density polyethylene made by Celanese Corp. of America.

No-Vac Nursing unit.

*Readers' Service Item 42*

## Phenolic Saucepan Handles

Handles on Enterprise Aluminum Co.'s line of thin-gage aluminum pots and pans are being manufactured from a phenolic which stays cool and is lightweight, economical, strong, and rigid. Designed by Watertown Manufacturing Co., the wide-based handles are attached to aluminum brackets, rather than to the pan. This, as well as the channeled handle, is reported to allow the greatest possible heat dissipation.

Enterprise Phenolic pan handles.

*Readers' Service Item 43*

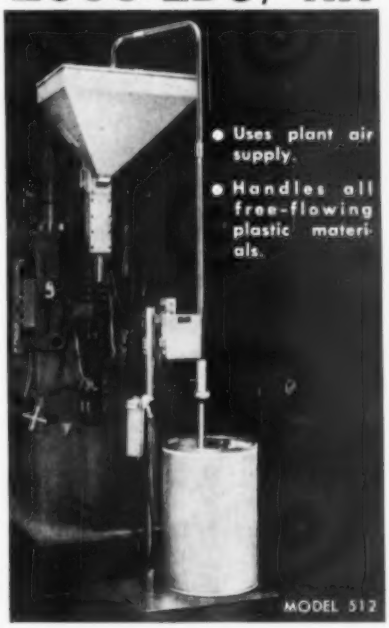
## Multi-Purpose Food Savers

High density polyethylene containers with sliding lids of transparent styrene are designed for economical food storage. The three-quart Slide-Top Food Savers, molded by Transparent Specialties Corp. from Grex polyethylene, are 9½ inches long, 6⅛ inches wide, and 3 inches long. The bottom parts of the food savers can be cleaned in a dishwasher as they withstand water well above the boiling point. They are unaffected by detergents and most chemicals, and will withstand repeated dropping.

The containers weigh about ten ounces and are available in several colors. The


AUTOMATIC AIR CONVEYORS HANDLE UP TO . . .

2500 LBS/HR




- Self-supporting—no attachment to machine required.
- Automatic or manual—full range of sizes.
- Ideal for proportioning—transfers directly from shipping containers.
- Interdepartmental transfer of materials possible.

Whitlock screw-type conveyors for dust-free loading.

Whitlock hopper-dryer — dries air to —20 dewpoint.

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Title

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*William D. Hedges, Vice President in Charge of Development and Research at Columbus Coated Fabrics Corporation, says:*

"I am responsible for seeing that raw materials meet our specifications and that the finished products meet the rigid quality requirements of our customers.

"In order to maintain our position as one of America's leading producers of quality vinyl products for home and industry, we must depend upon reliable raw material suppliers.

"For much of our basic research we must rely on the research and development laboratories of our vendors to keep us well informed of their current products as well as new materials which they are planning for the future.

"We judge all our suppliers—including plasticizer producers—in terms of these criteria, and only the best are selected for a continuing business relationship with us."

*Where the accent's on quality*
*look for* ***Plastolein® Plasticizers***

Emery

**Organic Chemical Sales Department**
**EMERY INDUSTRIES, INC., CAREW TOWER, CINCINNATI 2, O.**
Vopcolene Division, Los Angles; Emery Industries (Canada), London, Ont.
Export Department, Cincinnati

Slide-Top Food Savers.

polyethylene is Grex, a product of W. R. Grace & Co.

*Readers' Service Item 44*

## Plastic Cowboy Gun

Kusan, Inc., is producing a seven-item line of K-Pop plastic guns which shoot table tennis balls. The black vinyl guns pop the balls as far as 40 feet.

Two display units are available to retailers. Both single and repeater guns, with or without holsters, are being made.

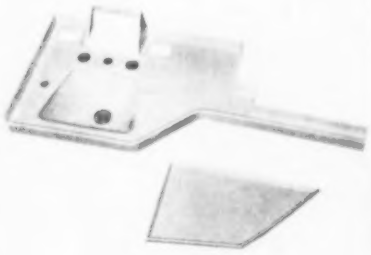
Kusan's K-Pop Korral.

*Readers' Service Item 45*

## Complex Melamine Products

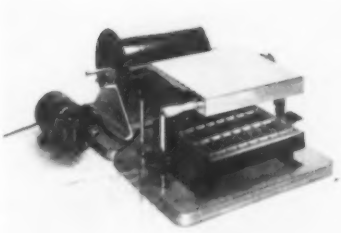
A single-piece melamine lavatory vanity table-and-washbasin is being produced by American Aerophysics Corp. for all DC-8 jet liners. The change from metal to plastic is reported to yield not only a weight saving of up to 50%, but sanitary advantages.

The unit is molded with a 1,100 ton press. It is resistant to burns, acids, scratches, and alcohol, and is unbreakable in normal usage.



Melamine table-and-washbasin.

*Readers' Service Item 46*



Production Vac 133 table-model former.

## Table Model Vacuum Former

A production-level vacuum forming unit which measures but 25 by 48 inches is available from Plast-O-Craft Co. Designed to complement the portable test unit, the Production Vac 133 has a forming area 11 by 12 inches. It handles both straight and drape forming.

Vac 133 can be sheet or roll fed. It has a powerful, high-speed electric pump and is wired for 110 volts. The surface is coated with black enamel.

*Readers' Service Item 47*

## Timing Light

The King Electric Equipment Co.'s timing light, used to adjust ignition timing while the automobile motor is running, has a case molded from Eastman's Tenite butyrate. In use, the timing light leads are

*Temperature extremes—*
which can rob vinyls of flexibility—are of little concern to producers who specify Plastolein low temperature plasticizers for their products. For example . . .

They know that Plastolein 9058 DOZ is the time-tested standard of the low temperature plasticizer field . . . that it provides the kind of low temperature flexibility *that stays in* their vinyls even after prolonged exposure to summer heat.

And more and more producers are utilizing the unusual capabilities of another Emery plasticizer, Plastolein 9078 LT, which approximates 9058 performance, but at a much lower price.

Why don't *you* investigate the advantage of these Plastolein Plasticizers in your coated fabrics, film, sheeting and extrusions?

Write Dept. Q-9 for literature.

PLASTOLEIN® plasticizers
Emery

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Emery Industries, Inc., Carew Tower, Cincinnati 2, Ohio
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Emery Industries (Canada), London, Ontario
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All Hartig research and development has been directed toward greater production efficiency. Today, Hartig extruders are known for their high production rate; ease of set-up, start-up and purging; for automatic operation requiring less skilled manpower; and for the fine control essential to precision extrusion and quality.

Hartig extruders and matched auxiliary equipment are ruggedly built to stand up for long continuous runs with minimum down time for maintenance.

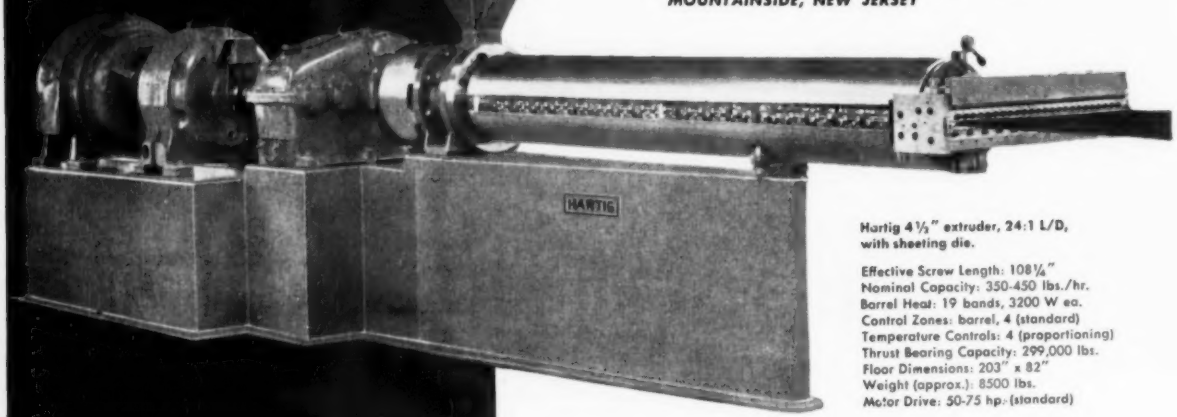
As a result, in shops equipped with Hartig and one or more other makes, you will usually find Hartigs logging more production time. We will be glad to give you facts and figures on Hartig equipment for your operation.

*Send for your copy*

of the new illustrated booklet describing the line of Hartig Extruders and Matched Auxiliary Equipment.

**HARTIG EXTRUDERS**

***Division of Midland-Ross Corporation***
***MOUNTAINSIDE, NEW JERSEY***




**Hartig 4½" extruder, 24:1 L/D, with sheeting die.**

Effective Screw Length: 108¼"
Nominal Capacity: 350-450 lbs./hr.
Barrel Heat: 19 bands, 3200 W ea.
Control Zones: barrel, 4 (standard)
Temperature Controls: 4 (proportioning)
Thrust Bearing Capacity: 299,000 lbs.
Floor Dimensions: 203" x 82"
Weight (approx.): 8500 lbs.
Motor Drive: 50-75 hp. (standard)

King timing light.

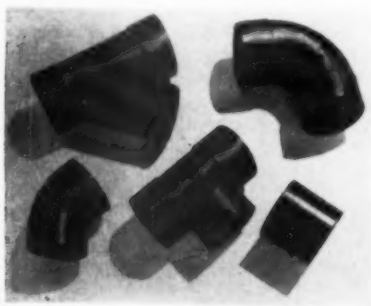
connected between the coil secondary and the distributor center tap. The light is aimed at the timing mark and any change in ignition timing is then made by distributor adjustment.

The case is molded by Recto Molded Products, Inc.

*Readers' Service Item 48*

## Molded Plastic Pipe Fittings

Four-inch fittings for their "D" sewer and drain pipe have been announced by Carlon Products, Inc. Made of high-impact plastic, the single piece fittings come in Y's, T's, 45° and 90° elbows, and couplings. The fittings are welded to the pipe with a brush and solvent cement. The sanitary fittings will not absorb water and are immune to rust and electrolytic corrosion. They will withstand common household chemicals and detergents, sewer gas, and soil corrosion.



Carlon molded fittings.

*Readers' Service Item 49*

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**RC cooks never run out of tested recipes for top performance. Through sound research and solid experience, RC Plasticizers and Insular Resins provide your wire and cable with three vital electrical prerequisites: high insulation resistance, ease of processing and maximum durability. RC Plasticizers and Insular Polymers and Copolymers can be successfully applied to an impressive range of applications. We solicit your inquiries for advice, technical bulletins and samples. Remember, your product performance will prove . . . RC was there!**

**Now available: New booklets on "RC Plasticizers and Comonomers," "Insular Polymers and Copolymers."**

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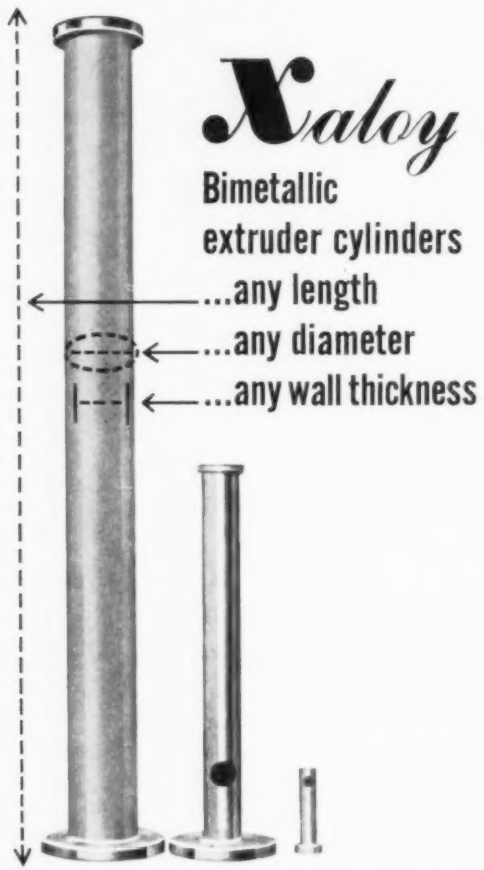
XALOY...used for a quarter of a century...worldwide




Xaloy production and engineering facilities are the largest in the world devoted *exclusively* to bimetallic extruder cylinders. Xaloy cylinders are designed to increase your output, expand your production time, cut your replacement costs and reduce your down-time. *Xaloy...original equipment on all leading extruders–and the logical replacement for every extruder.* Write for new Xaloy Engineering Data Guide.

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TESTING MACHINES, INC.

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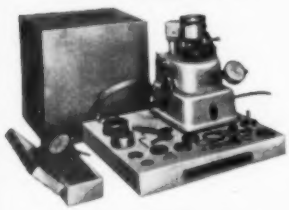
1079 Testing Machines available from TMI . . . with Special Emphasis on Rubber & Plastic Testers

ONE EXAMPLE:



Wallace Micro-Hardness and Softness Tester

QUICK, ACCURATE TESTS FOR
HARDNESS — SOFTNESS — CURE — FLOW CHARACTERISTICS

A Micro-Hardness and Softness Tester to provide new tests and new information!
Eliminates moulding standard size specimens.
Accurately tests smallest fragments.
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No problem testing thin sheets or coatings.
Simple to determine indentation and recovery.
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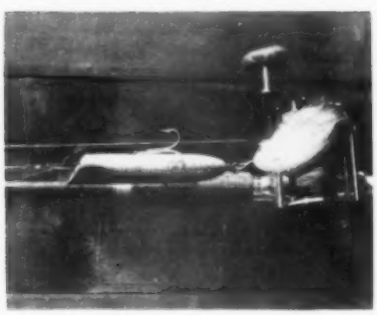

Stripper Striker fish lure.

### Tenite Butyrate Lures

The Bradson Wavefish lure, molded of Eastman's Tenite butyrate, incorporates a free-hanging hook harness, whose swaying movements as the lure is retrieved give the impression that the lure is alive.

The Striper Striker fish lure, produced by Creek Chub Bait Co. also from Eastman Tenite butyrate, is designed for salt water trolling. Cylindrical in form, it has one round and one flat end, so that it rides, cuts, and slaps the water as it is trolled. Amber, silver, and blue finishes, which form an integral bond with the butyrate, are available.

*Readers' Service Item 5*

Headache?

KEEP US IN MIND!

Rx . . . . . for relief of YOUR plastic problems. Quality P.V.C. Resins, Plasticizers, Stabilizers, and Chelators available on a moment's notice . . . For best results apply with large liberal auxiliary dosage of *complete* Technical Service backed up by years of successful plant use and advanced Research.

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BROOKLYN 34, NEW YORK

# New Literature

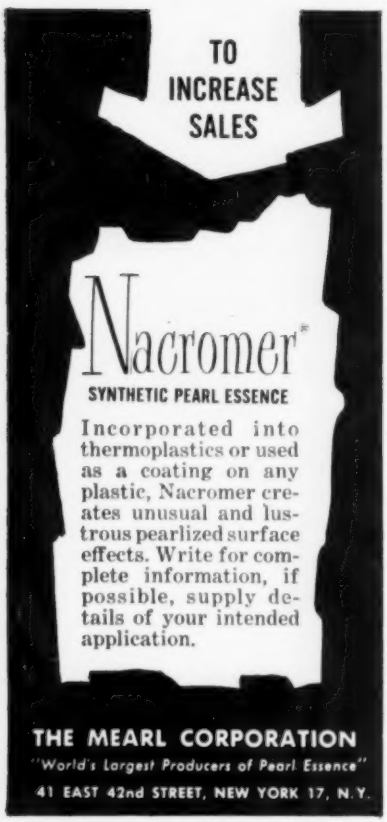
*Write Item Numbers on Readers' Service Card (p. 123) to obtain more information.*

**"Flexible and Molded Electric Heaters by Chromalox."** Bulletin J-1003. Edwin L. Wiegand Co. 4 pages. The firm describes its heaters which measure smaller than a postage stamp up to 24 inches wide by 125 inches long. They can be shaped or wrapped to fit almost any item, and the heat pattern within each unit can be built to match the work requirement. Voltages range from 2-250 volts, and from fractional up to 15 watts per square inch. Temperature limitations vary according to the sheath material and range up to 800° F.

*Readers' Service Item 61*

**"Alsynite—Modern Versatile Building Material."** AE-458R. Alsynite Co. of America. 4 pages. Specifications are given for a new line of translucent fiberglass-polyester panels, including flat panes for window glazing.

*Readers' Service Item 62*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**"Introducing the New Comet Star."** Comet Industries. 4 pages. Specifications are given for the unit, and a series of drawings show how it performs vacuum snap-back, plug assist, blow-up vacuum reverse, reverse draw, billow forming, and male assist pressure forming.

*Readers' Service Item 63*

**"Statfoam Automatic Metering & Mixing Equipment."** Dayton Rubber Co. 4 pages.. Specifications are given for 10 machines for mixing and metering urthane prepolymers for foaming in place. Capacities range from ½-80 pounds per minute.

*Readers' Service Item 64*

**"Chemical and Physical Properties of Nopcofoam."** Nopco Chemical Co. 16 pages. The booklet provides physical and chemical data on both polyester and polyether types of flexible urethane foams. Information given is about half copy and half tabular.

*Readers' Service Item 65*

**"The Handbook of High Voltage Electron-Beam Processing."** Bulletin P. High Voltage Engineering Corp. 32 pages. This illustrated bulletin answers questions on types and sources of radiation, developing radiation processes from research, engineering factors in design, efficiency of electron-beam utilization, beam power output and production capacity, installation and use of electron accelerators, and the economics of radiation processing. Graphic and tabular data offer calculations for such variables as optimum weights and thicknesses of processed material and power requirements per pound and linear rate.

*Readers' Service Item 66*

**"The Jet Pulverizer for Dry Pulverizing of Materials to Micron-Size Powders."** Jet Pulverizer Co. 4 pages. The units are available in eight custom-made sizes with mill diameters from 2-36 inches, and are operated either by compressed air or by super-heated steam.

*Readers' Service Item 67*

**"Walker Turner Light-Heavyweight Machine Tools."** WT-50-9. Walker-Turner division, Rockwell Mfg. Co. 48 pages. This illustrated catalog describes the firm's tools and accessories, including drill presses, grinders, cut-off machines, band saws, and belt & disc surfacers. Complete specifications are given.

*Readers' Service Item 68*

**"Alkyl and Alkylene Amines."** Union Carbide Chemcals Co. 52 pages. Properties and uses are given for 19 amines, the alkylenes being used in polyamides, epoxies, chelating agents, and finishing agents.

*Readers' Service Item 69*

**"Polyethylene Bag Calculator."** Slide Rule. U. S. Industrial Chemicals Co. Designed for packagers and converters, it gives such bag and film values as width, length, total area, weight, and gage. One setting of the slide rule allows the user to determine a variety of measurements with only one or two constants known.

*Readers' Service Item 70*

**"Dicyclopentadiene Dioxide."** Technical Bulletin No. 95. Food Machinery & Chemical Corp., chemicals & plastics division. 3 pages. The material is a difunctional epoxide used either as a modifier of conventional epoxy resins, a building block for epoxies, or as a plasticizer for alkyds.

*Readers' Service Item 71*

**"Plastic Machines for Every Molding Job."** Bulletin 5830-A. Hydraulic Press Mfg. Co. 6 pages. This bulletin describes the company's complete line of injection, compression, transfer, and reinforced plastics molding presses. Complete specifications are listed.

*Readers' Service Item 72*

**"Limonene Dioxide."** Technical Bulletin No. 96. Food Machinery & Chemical Corp., chemicals & plastics division. 4 pages. This material combines the reactivities of an internal and an external epoxy group in the same material. It can be used as a reactive diluent for epoxies or as a primary building block for an epoxy system.

*Readers' Service Item 73*

**"Ferro Cobalt Activators for Polyester Curing."** Technical Bulletin No. 48. Ferro Chemical Corp. 3 pages. The firm's cobalt compounds are listed along with their uses as activators for standard catalysts in polyester curing.

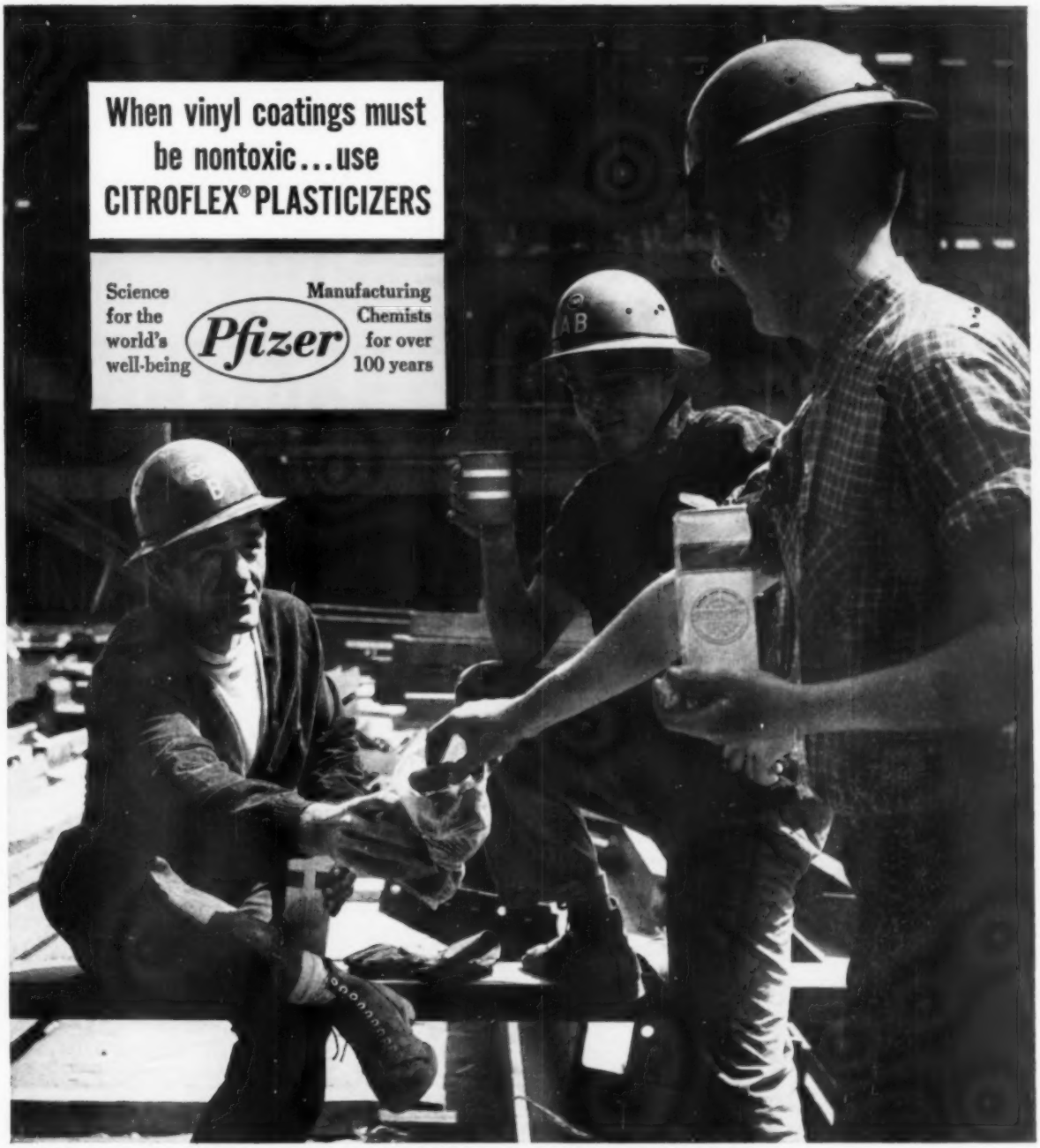
*Readers' Service Item 74*

**"Danco Today."** Danielson Mfg. Co. 2 pages. This bulletin describes the company's facilities and products.

*Readers' Service Item 75*

**"Vibra-Flow Vibratory Feeders."** Syntron Corp. 32 pages. This well-illustrated catalog describes the company's line of feeders which are said to make bulk materials "flow like water" with rheostat or reactor control of rate of flow. They operate through a trough which is mounted on flexible leaf springs and vibrated at a high speed by an electromagnet.

*Readers' Service Item 76*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# Book Reviews

**"Unit Processes in Organic Synthesis."** Fifth Edition. P. H. Groggins, Editor. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. Cloth, 6 by 9 inches, 1,070 pages. Price, $17.50.

This text and plant reference work, intended for persons with thorough grounding in physics, physical chemistry, and mathematics, describes and analyzes unit processes in relation to the chemical engineering aspects of organic synthesis: converting organic raw materials into usable products. Emphasizing fundamental scientific and technological principles, rather than manufacturing processes, the author takes into account advances in theory as well as practice by including three introductory chapters on thermodynamics and kinetics.

The unit processes treated encompass the major reactions of synthetic organic chemistry. Each process is introduced with a survey of the field; subsequently, chemical, thermodynamic, kinetic, and engineering factors are discussed; equipment and materials of construction are described; and, finally, examples of industrial applications are presented.


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Members of the American chemical industry have written the specialized material. E. F. Izard has contributed four sub-divisions of the chapter, "Esterification." Polyethylene terephthalate, used in manufacturing American Dacron polyester fiber, Mylar polyester film, and Cronar photographic film base; Canadian and English commercial Terylene; and German Hostaphan film; is prepared by transesterification between dimethyl terephthalate and ethylene glycol. Beginning with preparation of the reactants, the discussion describes a method of production which, like others in the volume, is commercially profitable.

Mr. Izard also presents formulations and procedures for preparing simple alkyd resins modified by linseed oil, vinyl acetate to be used for preparing polyvinyl acetate, and methyl methacrylate to be used as a base for compositions like Lucite and Plexiglas.

Almost 200 pages are devoted to polymerization. Divided into two sections, the first presents the theoretical principles of polymer chemistry, classifying polymers by molecular-weight averages, distribution curves, chain structures, and technical tests such as thermal and chemical, permanence, mechanical, optical, and electrical.

Part 2 comprises industrial polymerization practices and materials obtained from them. Limited to processes and products which are in practical commercial and industrial use, the section discusses phenolics, ureas and melamines, alkyds, polyamides, polyesters, epoxies, silicones, isocyanates, polysulfides, polyethylene, vinyls, polystyrene, acrylates and methacrylates, acrylonitriles, polyisobutylenes, allyls, and synthetic dienes. Chemical equations illustrate preparation of these resins.

The text is amplified by schematic diagrams of resin production and tables of physical properties.

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**"A Guide to Plastics."** C. A. Redfarn. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. Cloth, 5½ by 8½ inches, 150 pages. Price, $5.00.

Since this is not a conventional textbook, but rather a condensed guide of general information about the nature and uses of plastics, no chemical formulas are included, and technical terms are used as sparingly as possible.

Commencing with a chapter on plastics nomenclature, the author clearly outlines the manufacture of plastics from raw materials, through preparation of resins, to fabrication processes. The text is graphically enhanced by a series of 17 colored flow charts tracing plastics production through basic raw materials; intermediates raw materials; monomers and polymers; molding materials; sheets, tubes, rods, and filaments; and chief applications. Schematic line diagrams explain plastics fabricating machines; and three series of line drawings develop compression, transfer, and injection molding operations, illustrating the successive positions of the machine components.

British Standards Institution plastics standards, definitions of physical properties, and a chart comparing physical properties are included. Because of the condensed, non-technical nature of the book, few references are given. However, a short, selective book list is supplied.

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**"The Encyclopedia of Chemistry (Supplement)."** Editor-in-chief George L. Clark. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Cloth, 7 by 10¼ inches, 330 pages. Price, $10.00.

The Supplement, a companion volume to the original Encyclopedia, adds over 200 articles of primary and current interest. Arranged in alphabetical order by subject, each article is contributed by a chemical and/or industrial authority. Each article is cross-referenced at the end.

Because the book is not intended for professional chemists, the emphasis is on basic concepts and developments. Strong emphasis is given to the impact on chemistry of nuclear phenomena.

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**"Epoxy Resins."** Irving Skeist. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y. Cloth, 5 by 7½ inches, 293 pages. Price $5.50.

The eighth in Reinhold's Plastics Applications Series, this volume describes the properties, chemistry, and applications of epoxies. The semi-technical book is intended for industrial workers such as design engineers, equipment manufacturers, package producers, manufacturers of packaging machines; students at technical schools; and plastics material manufacturers, molders, extruders, and fabricators. It not only presents manufacturing procedures and formulations, but theory as well.

George R. Somerville has contributed a comprehensive chapter on "Properties and Applications of Epoxy Resins in Surface Coatings." In this chapter and in the remainder of the book, materials are discussed not only by type but by brand name.

Among the most important uses of epoxies are casting and laminating metalworking tools. In both the automotive and aircraft industries, where parts must be tooled for relatively short runs, the use of epoxies is increasing. They are especially valuable for reproducing compound curvatures. Epoxies are also growing in use for electrical embedments and for adhesives, caulking, and patching. Possible future applications for epoxies, now in experimental or theoretical stages, include molding compounds, foams, dentures, road surfacing, textile finishing, and photoelastic stress analysis.

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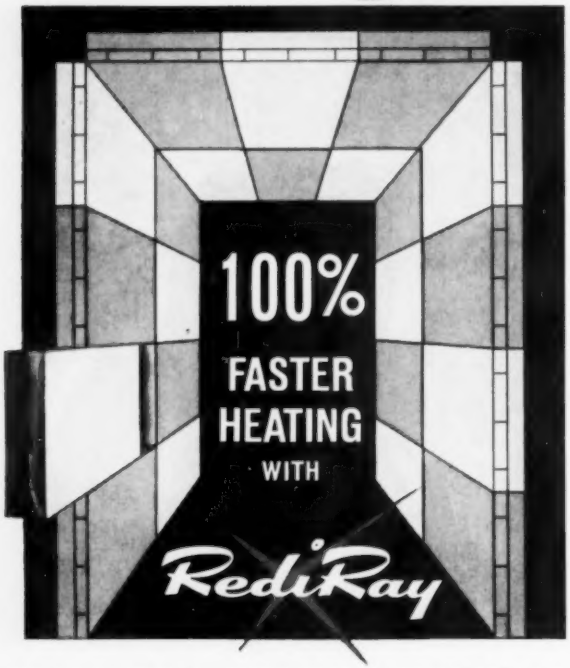


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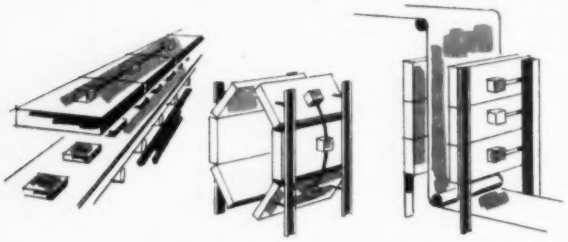

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# Abstracts of Important Articles

## Materials

**"Viscometric Behavior of Copolymers of Vinyl Acetate and Vinyl Chloride,"** G. Ciampa, *Mat. Plastiche*, 24, 3, 209 (March 1958).

Results are reported of viscometric examinations of a series of copolymers of vinyl chloride and vinyl acetate having substantially the same K value (55), but with vinyl acetate content ranging up to 30%. (In Italian.)

**"Identification of Some Chlorine-Containing Polymers,"** D. Hummel, *Kunststoff Rundschau*, 5, 3, 85 (March 1958).

Previously-published findings of investigations aiming at identifying PVC and polyvinylidene chloride by color reactions resulting from treatment with pyridine and methanolic sodium hydroxide suggested that the method might be applicable also to other chlorine-containing polymers such as re-chlorinated PVC, rubber hydrochloride, chlorinated rubber and neoprene. The procedure followed and results are described. (In German.)

**"The Electron Microscopy of High Polymers,"** N. H. Langton and M. Stephen, *Plastics, (London)*, 23, 253, 384 and 23, 256, 422 (Oct. & Nov. 1958).

The principles of electron-microscope examination of high polymers, fillers, and other materials used in the plastics industry are described. The special problems involved in applying the method to high polymers are explained. The examination of powders and latices, the shadowing and replica technique, the cutting and examining thin sections, and the interpretation of results are dealt with.

**"Factors Affecting the Tensile Strength of Phenolic Moldings,"** F. R. Smith and J. A. Laird, *Brit. Plastics*, 31, 11, 477 (Nov. 1958).

Investigations showed that five possible factors affected the tensile strength of phenolic moldings. Variations in pre-form shape and pre-heating resulted in significant variations in tensile values. Evidence was found that flow and orientation of the molecules during molding, the uniformity of temperature of the pre-heated material, and the approach to an optimum pre-heating temperature are the fundamental factors which control tensile strength of phenolic molding powders.

**"The New Epoxy Building Materials,"** M. W. Riley, *Materials Design Eng.*, 49, 6, 69 (June 1959).

A short review comparing the new epoxies with DAPs, silicones, and alkyds.

**"Interfacial Polycondensation—A Versatile Method of Polymer Preparation,"** P. W. Morgan, *SPE J.*, 15, 6, 485 (June 1959).

A discussion of a new method for polymer preparation suitable for use with many polymers not previously accessible to the melt index method.

**"The Comparison of Time Dependent Mechanical Properties of Plastics,"** Bryce Maxwell, *SPE J.*, 15, 6, 480 (June 1959).

A discussion of the basic principles behind creep, stress relaxation, and dynamic properties.

**"Makrolon—a Thermoplastic Polycarbonate. Part I. Production and Properties,"** W. Hechelhammer and G. Peilstoecker, *Kunststoffe*, 49, 1, 3 (Jan. 1959).

Makrolon is the name of the Bisphenol-A polyester of carbonic acid developed by Farbenfabriken Bayer. Available as granules, the material is a thermoplastic, has a high-melting range and an unusual combination of excellent properties, and can be processed by all the usual methods for plastics. Production, and physical, electrical, and chemical properties are described. (In German.)

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in October. The last listing appeared in the June issue.

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## Applications

**"Tough, Chemical Resistant Urethane Coatings,"** R. S. Sansone, *Materials Design Eng.*, 49, 6, 80 (June 1959).

A brief review of the types of coatings, their use, and their properties.

**"Decorative Thermosetting Laminates,"** W. T. Davis, *Materials Design Eng.*, 50, 1, 96 (July 1959).

A brief discussion of the laminates and their properties, together with some of their decorative uses.

**"Reinforced Plastics for Rocket Motor Applications,"** George Epstein and J. C. Wilson, *SPE J.*,

A discussion of the advantages, reinforcements, fillers, and binders for reinforced plastics in rocket motors, together with some of their applications.

**"Industrial Applications of Solid Polyurethane,"** K. H. Grim, *Plastics Ind.*, 17, 7, 34 (July 1959).

Product types described include accumulator bladders; contact, lift-truck, wire-measuring, and airplane wheels, liquid oxygen containers and pump stators and impellers.

**"Reinforced Plastics Ventilating Ducts,"** M. Lenzini, *Mat. Plastiche*, 24, 3, 204, (March 1958).

In a large industrial plant in Italy, two glass-reinforced plastics ventilating systems recently were installed. The properties of the materials used and the design and construction of the ducts are described. The principal technical advantages over similar metal ducts are detailed. (In Italian.)

**"Polystyrene Shoe Heels,"** J. S. Harding, Rubber & Plastics Age, 39, 9, 749 (Sept. 1958).

The trend in plastics heels in the United States and in Britain is compared. Details are given on the British market for polystyrene heels, as well as on their manufacture and future prospects.

**"Copper-Plated Laminates for Printed Circuits,"** C. Brinkmann, *Kunststoffe*, 48, 12, 575 (Dec. 1958).

Quality requirements of insulations and methods of making copper-plated laminates for printed circuits are described. Particulars are given on the insulating supports used (phenolics, epoxies, silicones, P.T.F.E., polychlorofluoroethylene, and Mycalex-type materials), and their properties are tabulated. (In German.)

**"Plastics Binders for Increased Foundry Efficiency,"** H. Kalpers, *Plastverarbeiter*, 12, 12, 460 (Dec. 1957).

The use is described of German foundry core binders based respectively on urea resins and cellulose derivatives (methyl or carboxymethyl cellulose). (In German.)

**"Vacuum-formed Toys and Packaging,"** A. Riemenschneider, *Plastverarbeiter*, 9, 2, 41 (Feb. 1958).

Vacuum-forming is moving ahead in the toy and packaging fields, as indicated by exhibits at Nurnberg and Dusseldorf expositions held early in 1958. The method supplements, but does not replace, injection molding for these goods. (In German.)

**"Automobiles and Plastics Materials—Turin Exhibition, 1957,"** M. Parducci, *Materie Plastiche*, 24, 2, 101 (Feb. 1958).

Review of the use of plastics in various European and American cars seen at the 1957 Turin Exhibition. Included are Moplen parts, first introduced on Fiat cars. (In Italian.)

**"Some Application of Polyesters in the Insulation of Electrical Equipment,"** H. Debroise, *Pensez Plastiques*, No. 76, No. 87, 11 (Sept. & Dec. 1957).

Four forms in which polyesters are used in the insulation of components of electrical equipment are discussed: polyester-based coatings without solvent; loaded resins for filling, potting or sheathing of components; resins for bonding mica splittings and the like to paper or fiberglass supports; and finally, glass fiber-polyester laminates. Polyester coats are compared with those of other materials, and the methods of using the polyester resins and the properties of the products are described. (In French.)

## General

**"Automatic Control Devices to Improve Productivity in Plastics Molding Factories,"** R. Kainz, *Kunststoff-Rundschau*, 4, 11, 477 (Nov. 1957).

General discussion of advantages to molders of automatic devices which aid in controlling operation costs by recording various factors involved, such as ratio of idle to working time of the presses; when the presses actually were operating; when and why they were idle; uniformity of molding procedure; start and finish of work on an order, etc. (In German.)

**"College Courses in High Polymers,"** J. H. Day, *SPE J.*, 14, 12, 25 (Dec. 1958)

Copy of a report presented at the ACS symposium in Chicago on Sept. 7-12, 1958.

**"Nottingham Conference of High Polymer Technology,"** G. Glazer and N. H. Langton, *Plastics (London)*, 23, 252, 345; 23, 253, 381; 23, 254, 419 (Sept., Oct., Nov., 1958).

A report of the International Conference held in July 1958. Abstracts are given of the 48 papers presented.

**"Plastics Analysis and Testing in the Periodical Literature of 1956,"** K. D. Ledwoch and H. Meisel, *Kunststoff-Rundschau* 4, 11, 473; 4, 12, 526 (Nov. & Dec. 1957).

The authors review only the literature dealing with new analytical and testing methods, applications of known procedures in new fields, new apparatus, new standards, and test specifications. The material is divided under several heads: general analytical work concerning plastics as a whole; testing methods for thermoplastics, thermosets, natural high polymers; basic materials, adjuvants, other polymers; manufactured goods; tools and apparatus; standards and specifications. (In German.)

**"Education and Research in Germany and Holland,"** J. E. Stucky, *Rubber & Plastics Age*, 39, 4, 278, (April 1958).

The author reports on what he saw of industrial processing, fabrication, research and education in plastics while on a tour of Germany and Holland, and compares developments there with those in Britain. The rubber and plastics factories, and special institutes visited by him are separately listed.

**"Plastics in East Germany. An Appraisal of the Industry and its Needs,"** M. Kaufman, *Plastics (London)*, 23, 252 324 (Sept. 1958).

The Senior Lecturer in Plastics Technology of the National College of Rubber Technology, London, reports on the situation in plastics as he found it last year, discussing available raw materials, main products, applications, research and development, and future plans, with an eye to possible business for British suppliers, particularly of plastics machinery.

**"Plastics: 8.1 Billion Pounds in 1965,"** A. F. Sward, *Chem. Eng. News*, 37, 27, 30 (July 6, 1959).

A forecast of the industry's growth to 1965.

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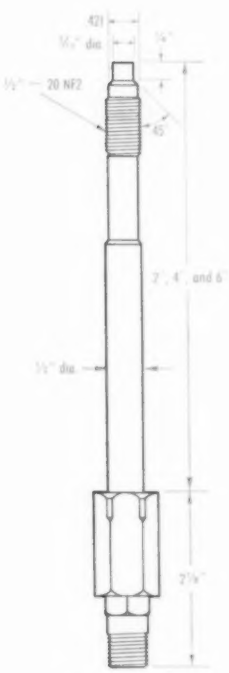


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# Patent Digest

## Materials

**High Molecular Weight Cross-Linked Polyester-Urethane Elastomer Products.** No. 2,861,972. Karl E. Muller and Otto Bayer, Leverkusen-Bayerwerk, and Siegried Petersen, Leverkusen, Germany. (to Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, Germany).

An organic diisocyanate and an aromatic glycol are reacted with an anhydrous, organic, linear polyester having 0.6-2.4% by weight of hydroxyl groups and an acid value not exceeding one. The polyester is prepared from a saturated, aliphatic, dicarboxylic acid and a glycol. Thei mprovemert is said to lie in the glycol, which has two condensed aromatic rings and two aliphatically-bonded —OH groups linked to the aromatic rings through alkylene groups. The latter are connected to the aromatic rings by ether or carboxylic linkage.

**Molding Compositions of High Molecular Weight and Low Molecular Weight Polymers.** No. 2,864,802. Raymond M. Price, Midland, Lewis J. Young, Sanford, Bernard H. Tubbs, Clare, and Robert E. Lee, Midland, Mich. (to Dow Chemical Co., Midland, Mich.)

Two compatible, normally solid, thermoplastic resins, one containing at least 60% polymers or copolymers of monovinyl aromatic hydrocarbon of the benzene series, and the other a polymerized monoalkenyl aromatic hydrocarbon of the benzene series having a single ethylenically unsaturated group of the formula $CH_2=CR$, R representing a member of the group of hydrogen, methyl, and ethyl radicals, are used. The second has an average molecular weight not more than one-third as great as that of the first.

**Stable Emulsion Containing an Acrylate, Acrylic Acid, and an Acrylonitrile.** No. 2,868,752. C. Frazier, Yonkers, N. Y. and J. H. Fortune, Springdale, Conn. (to American Cyanamid Co., New York, N. Y.).

A thermoplastic freeze-thaw and mechanically stable tripolymer emulsion composition have a pH greater than 7.

**Mixtures of Polyethylenes having Different Melt Viscosities and Process of Preparing Same.** No. 2,868,762. W. G. Oakes, Northwich, England (to Imperial Chemical Industries Ltd., London, England).

A homogeneous polyethylene composition, extrudable at high pressures and high rates of shear with a minimum of power.

**Corrosive Resistant Polyethylene Emulsions.** No. 2,868,742. R. R. Burnham, Eggertsville, N. Y. (to Union Carbide Corp.).

A corrosive resistant oil-water emulsion, the oil phase containing 4.8 to 7.5 parts of polyethylene.

**Vinyl Chloride Resin Stabilized with Three Component Stabilizer.** No. 2,868,745. C. M. Canarios, E. Cleveland, O. (to Harshaw Chemical Co., Cleveland, O.).

A heat stable polyvinyl chloride resinous composition comprising vinyl chloride resin and from 0.5 to 10 parts of a stabilizer PHR. The stabilizer consists of from 0.5 to 30% of 3,6-endomethylene-delta-4-tetrahydrophthalic anhydride by weight, from 0.1 to 10% of 4,4'-thiobis-(6-tertiary-m-cresol) by weight, and the balance a metallic soap.

**Thermoplastic Polyamide-Epoxy Adhesives.** No. 2,867,592. T. C. Morris, Lexington, Mass., and A. M. Chaplick, Hudson, N. H. (to B. B. Chemical Co., Boston, Mass.).

A permanently fusible, thermoplastic adhesive comprising a resinous polyamide reaction product of a polymeric polyene fat acid and an alkylene polyamine possessing at least two primary amino groups, and a minor proportion of a resinous polyepoxide reacted with said polyamide. The polyepoxide increases the dimensional stability and strength of the composition.

**Vinyl Chloride Resin Stabilized with 2-Ethyl Hexyl Aryl Phosphites.** No. 2,867,594. F. R. Hansen, Bedford, and B. Zaremsky, Cleveland, O. (to Ferro Chemical Corp., Bedford, O.).

Polyvinyl chloride resin stabilized with 0.1 to 20 parts PHR of diphenyl mono-2-ethyl hexyl phosphite.

**Process for Preparing Foamable Carbon Dioxide-Containing Styrene Polymer Composition and Foamable Composition Thereof.** No. 2,864,778. J. L. Mladinich, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

A composition of matter comprising a foamable styrene polymer having incorporated therein a foam-producing quantity of an aliphatic hydrocarbon boiling in the range of 10-80° C., and carbon dioxide in the amount of at least 0.0002 weight per cent of the total composition.

**Certain Oxyalkylation Derivatives of Polyepoxide Modified Phenol-Aldehyde Resins.** No. 2,864,806. M. De Groote, St. Louis and Kwan-Ting Shen, Brentwood, Mo. (to Petrolite Corp., Wilmington, Del.).

An oxyalkylation-susceptible, fusible, organic solvent-soluble, water-insoluble phenol-aldehyde resin and a non-aryl hydrophile polyepoxide are combined to form a member of the class of acylation- and oxyalkylation-susceptible solvent-soluble liquids and low-melting solids.

**Polyamides from Branched Chain $C_8$ $C_{10}$ Diamines.** No. 2,864,807. J. F. Nobis and H. Greenberg, Cincinnati, O. (to National Distillers and Chemical Corp., N. Y., N. Y.).

A fiber-forming, cold drawable, linear polyamide having as a sole complementary polyamide-forming constituent an acid selected from sebacic acid, adipic acid, and mixtures thereof and a saturated, aliphatic, branched chain diamine selected from 1,6-diaminooctane, 3,6-diaminooctane, 2-ethyl-1,8-diaminooctane, 2,5-diethyl-1,6-diaminooctane and mixtures thereof.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Prices, 25c each.
—The Editor

## Equipment

**Apparatus for Production of Films.** No. 2,863,172. Richard Harold Barclay Buteux, Welwyn Garden City, and Jack Witherington Cornforth, Harpenden, England (to Imperial Chemical Industries, Ltd., London, England.)

Apparatus for vertical downward extrusion of thin-walled tubing and tubular film through an annular orifice, with provision for introducing and maintaining a volume of gas in the tubing, and cooling the product. An annular reservoir for cooling liquid is defined by three annular walls, the inner being shortest, which form the passageway through which the liquid flows.

**Apparatus for Coating Stranded Conductors for Electric Cables.** No. 2,863,171. Edward Peter von Bergen, London, England (to International Standard Electric Corp., New York, N. Y.)

Apparatus for manufacturing a multistrand electric cable consisting of several insulated conductors, comprising a closing die formed with a tapered bore, an extrusion barrel, and a passage extending through the wall of the die intermediate with the ends of the bore and connecting the bore with the extrusion barrel.

*The newest curing agent for the EPOXY family – from Jones-Dabney Co. where Epoxy resins were developed . . .*

# epi-cure 855

## A New Flexiblizing Type Curing Agent For Improved Resilience

EPI-CURE 855 is a new and modified aliphatic amine curing agent for EPOXY resins, which has resulted from the continuing development in the Jones-Dabney Laboratories, where EPOXY resins were developed.

For casting compounds, laminated structural parts, potting and encapsulating EPI-CURE 855 provides several unique advantages.

Lower viscosity improves mixing and handling ease, eliminates the use of diluents in many cases and often lowers the cost of finished compounds.

Complete compatibility with EPI-REZ® 510 and similar resins allows faster and more uniform mixing. Bubbles come out faster and preheating and waiting periods before application are eliminated. Now you can handle compounds at lower temperatures with less sweat-out.

Longer pot-life permits larger batches and more time for application. After application there is more time for bubbles to surface and break resulting in better wetting.

When You Think of Epoxy Resins, Come to the People Who Pioneered in Their Development and Manufacture!

Direct inquiries to Resin and Chemicals Division, Station E, Louisville 8, Ky.

**JONES-DABNEY CO.** Division of Devoe & Raynolds Co., Inc.

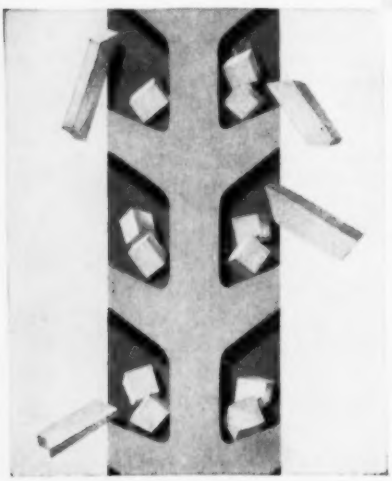
• Louisville, Ky. • Newark, N. J. • Los Angeles, Calif.

# Lately more plastics materials are being sized and separated by Simon-Carter machines

CARTER GRADERS PERFORM THICKNESS, WIDTH SEPARATIONS

For sizing or separating free-flowing granular materials by *thickness*, Carter Precision Graders use revolving cylinders with *slotted perforations at the bottom of grooves*. Saddles between these grooves upedge the materials presenting them to the slots in an edgewise position. The thinner pieces pass through and the thicker pieces pass over and are conveyed to the end of the machine.

For *width* sizing or separating the Precision Graders use revolving cylinders with *round recessed perforations*. The recess causes the materials to be presented to the round perforations in an upended position. Narrow pieces pass through and wider pieces pass over for discharge at the end of the cylinder.



CARTER SEPARATORS ASSURE POSITIVE LENGTH SEPARATION

Carter Disc Separators contain a series of discs mounted on a revolving horizontal shaft. Each disc has hundreds of undercut pockets which select or reject plastics or similar materials according to *length*. As the discs revolve through a mixture of materials, the pockets lift out the shorter pieces. The longer pieces, too long to be held in the pockets as they rise, drop away from the discs.

Write today for complete information and descriptive folders on Simon-Carter machines.

**SIMON-CARTER CO.**
677 Nineteenth Ave. N. E. • Minneapolis 18, Minn.



## *Positions Open*

Classified Rates $5.00 per Inch.

**PLASTICS TECHNOLOGIST**

An expanding division of Harshaw Chemical has an opening in Technical Sales. Service and field application work in paints and plastics. Some practical working knowledge of thermoplastic field and paint field is necessary. Chemical background preferred.

This is a new position creating a real opportunity for individual growth.

Please send details of education, experience and salary requirements. All inquiries will be handled promptly and held in confidence.

**D. E. Hyde**
**The Harshaw Chemical Co.**
**1945 E. 97th St.**
**Cleveland 6, Ohio**

**SALES REPRESENTATIVES WANTED:**

Parent corporation has openings on a national basis for established authorized manufacturers' representatives on strict commission basis in various divisional organizations.

1. DURABLE FORMED PRODUCTS, INC. Sales representatives wanted for custom vacuum-forming sales.
2. AIR-O-FLOW INDUSTRIES, INC. Agents wanted who specialize in sales of plastic machinery to sell automatic thermo-forming equipment.
3. TECHNI-PLASTICS, INC. Specialized sales for custom acrylic work, edge-lite panels, dials and knobs.

Indicate territory you cover. Write to:

**Durable Industries, Inc.**
**Chemical Corn Exchange Bldg.**
**74 Varick Street**
**New York 13, N. Y.**

**Urea and Melamine**
**MOLDING POWDER EXPERT**

Expanding Chemical Company requires a Chemist or Production Man completely familiar with every stage of Urea and Melamine Molding Powders production from the basic resin through to the finished powder. Location: Metropolitan New York area. Excellent opportunity for top man to participate on a profit-sharing basis with new producer of molding powders. Please give complete details of experience in first letter. **Box #22**

**PLASTICS TECHNOLOGY**
**630 Third Avenue New York 17, N.Y.**

**MANUFACTURERS AGENTS WANTED:**

Precision Built Duplex Slitter for plastic sheet and film. High quality German built machine. Men wanted handing active lines to industries using sheet and film.

**Box #21**
**PLASTICS TECHNOLOGY**
**630 Third Ave., New York 17, N. Y.**

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IN THE PLASTICS INDUSTRY

in next month's

EDITORIAL

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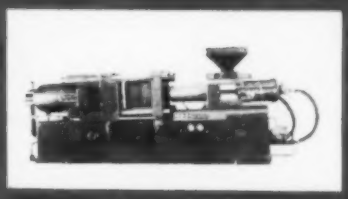
Voltrap The Complete Contact Insulator

- For Machine Parts
- For Liquids
- For Air

ALSO SPECIAL REQUIREMENTS

INDUSTRIAL HEATER CO., INC.
417 Canal St., New York, N. Y.



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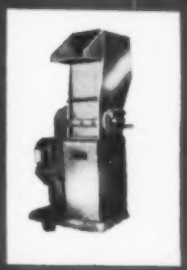
Systems for Injection Molding Machines



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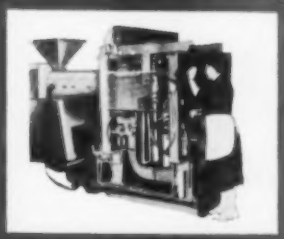

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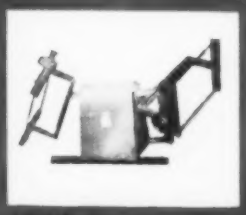
ACME

Plastics Machinery



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5 to 20 Drums

NEW! BOSS Extruders, with American Controls

ACME MACHINERY & MFG. CO., INC.

20 South Broadway 102 Grove Street 5222 W. North Ave.
YONKERS, N. Y. • WORCHESTER, MASS. • CHICAGO 39, ILL.
Yonkers 5-0900 Pleasant 7-7747 Tuxedo 9-1323

# Current Market Prices

## Price Changes and Additions

| | | | |
|---|---|---|---|
| **Catalysts** | | | |
| Heyden Newport Beta-S | lb. | $ .75 / | $1.00 |
| **Coating Resins** | | | |
| Rohm and Haas Acryloid | lb. | .265 / | .82 |
| Amberol | | | |
| Phenol formaldehyde type | lb. | .22 / | .3875 |
| Rosin maleic type | lb. | .2175 / | .3275 |
| Amberlac | lb. | .23 / | .3475 |
| Duraplex | lb. | .18 / | .465 |
| Rhoplex | lb. | .195 / | .405 |
| Uformite | lb. | .1975 / | .4125 |
| **Fillers** | | | |
| Conoco Demivis | lb. | .14 / | .18 |
| **Plasticizers** | | | |
| Conoco H-35 | lb. | .11 / | .14 |
| Monoplex DBS | lb. | .655 / | .685 |
| DCP | lb. | .25 / | .28 |
| DOS | lb. | .5925 / | .6225 |
| S-38 | lb. | .19 / | .22 |
| S-70 | lb. | .3925 / | .4225 |
| S-71 | lb. | .45 / | .48 |
| S-73 | lb. | .3475 / | .3775 |
| S-90 | lb. | .59 / | .625 |
| Paraplex G-41 | lb. | .53 / | .56 |
| G-54 | lb. | .4425 / | .4725 |
| RG-7 | lb. | .33 / | .335 |
| RG-8 | lb. | .505 / | .5125 |
| RG-10 | lb. | .52 / | .5275 |

| | | | |
|---|---|---|---|
| **Resins & Molding Compounds** | | | |
| **Polyether** | | | |
| Penton | | | |
| Natural | lb. | 3.50 / | 4.50 |
| Olive drab and black | lb. | 3.75 / | 4.75 |
| **Polypropelene** | | | |
| Pro-fax | | | |
| Natural | lb. | .42 / | .65 |
| Colors | lb. | .51 / | 1.11 |
| **Stabilizers** | | | |
| Ferro liquid | | | |
| 203 | lb. | .87 / | .97 |
| 703 | lb. | .65 / | .75 |
| 707X, 760X | lb. | .95 / | 1.05 |
| 900 | lb. | .90 / | 1.00 |
| 903 | lb. | .60 / | .70 |
| 904 | lb. | .84 / | .94 |
| 909 | lb. | .91 / | 1.01 |
| 1203 | lb. | 1.38 / | 1.48 |
| 1212A, 1234, 1237 | lb. | .62 / | .72 |
| 1701 | lb. | .58 / | .68 |
| 1720 | lb. | .70 / | .80 |
| Powdered | | | |
| 182 | lb. | .70 / | .80 |
| 503 | lb. | .30 / | .40 |
| 541A | lb. | .82 / | .92 |
| 768, 1825 | lb. | 1.00 / | 1.10 |
| 1820 | lb. | .90 / | 1.00 |
| 1827, 2020 | lb. | 1.05 / | 1.15 |
| 1840 | lb. | .75 / | .85 |
| 1976 | lb. | .47 / | .57 |

## CALENDAR of COMING EVENTS

**October 1-2**
SPI New England Section Conference, Wentworth-by-the-Sea, Portsmouth, N. H.

**October 7**
SPE Cleveland Section RETEC, Vinyl Plastics, Cleveland Engineering Society, Cleveland, O.

**October 13-14**
SPE Southern California Section NATEC, Plastics Engineering-State of the Art Today, Ambassador Hotel, Los Angeles, Calif.

**October 16**
SPE Buffalo Section RETEC, Plastics Finishing, Niagara Hotel, Niagara Falls, N. Y.

**October 17-25**
Plastics 1959-International Trade Fair of the Industry, Düsseldorf, W. Germany.

**October 28-30**
Society of Aircraft Materials and Process Engineers, Symposium on Sealants and Sealing of Aircraft, Missiles, and Electrical Components, Institute of Aeronautical Sciences, Los Angeles, Calif.

**November 2-5**
AIME Metallurgical Society Technical Committee on Chemistry and Physics of Metals, Fall Meeting; Symposium on Plastics and Ceramics, Morrison Hotel, Chicago, Ill.

**November 4**
SPE St. Louis Section RETEC, Plastics in the Shoe Industry, Statler Hotel, St. Louis, Mo.

**November 8-10**
Toy Production Show (originally scheduled for April 14-16), New York Trade Show Building, New York, N. Y.


**Positions Open**
Classified Rates $10.00 per inch.



**Directory**

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|---|---|
| 1 time | $19.00 per inch |
| 6 times | $18.00 per inch |
| 12 times | $15.00 per inch |



**Market Development — Polystyrene**

1. Do you have 7 or more years experience in polystyrene (or polystyrene and polyolefin) technical service or market development work?
2. Do you have a B.S. degree?
3. Do you have a "sales" type of personality?
4. Are you interested in an opportunity to grow with a dynamic, youthful organization?

If you can answer yes to all 4 of these questions, you may be just the man we're looking for. Write and send your detailed resume to:

**G. C. Ritter**
**Employee Relations Coordinator**
**Amoco Chemicals Corporation**
**910 South Michigan Avenue**
**Chicago 80, Illinois**



**WANTED TO BUY**
Used injection molding machines, ovens, granulators. One machine or complete plant.

**Acme Machinery & Mfg. Co., Inc.**
20 South Broadway, Yonkers, N. Y. YOnkers 5-0900
102 Grove Street, Worcester, Mass. PLeasant 7-7747
5222 W. North Ave., Chicago, Ill. TUxedo 9-1328



**FOR SALE**
Ovens, Grinders, Powder Mixers, Injection Molding Machines 1 oz. to 60 ozs. never used and used, Two-head Bottle Blowing Machines, Extruders, granulators and refrigeration systems.

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**PLASTIC SALES**

**For Men Capable in Selling Plastic Raw Materials**
**This Is a Major Opportunity**

Because of the dynamic growth of our plastics market we need additional sales representatives to cover midwest territories, calling on molders, extruders, calenderers, and "end users."

Applicants should have 2 to 7 years experience in field sales or sales technical service in plastics, rubber or allied fields, and should understand processing techniques. Moving expenses paid; car furnished; incentive with salary.

**E. M. Mills, Personnel Director**

**MARBON CHEMICAL**
**Division of Borg-Warner**
**Box 68, Washington, West Virginia**

# Domestic Production and Sales of Plastics and Resin Material, April and May, 1959

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of April and May, 1959. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

| | April, 1959 | | May, 1959 | |
|---|---|---|---|---|
| | Production | Sales | Production | Sales |
| Cellulose Plastics:[1] | | | | |
| Cellulose acetate and mixed ester: | | | | |
| Sheets, under 0.003 gage | 1,798,873 | 1,846,647 | 1,376,689 | 1,548,189 |
| Sheets, 0.003 gage and over | 1,914,359 | 1,706,607 | 1,824,158 | 1,645,083 |
| All other sheets, rods, and tubes (including other cellulose plastics) | 920,616 | 894,248 | 690,344 | 830,935 |
| Molding and extrusion materials (including other cellulose plastics) | 9,432,273 | 9,046,844 | 8,120,562 | 7,749,739 |
| Nitrocellulose sheets, rods, and tubes | 317,052 | 207,861 | 315,197 | 180,956 |
| TOTAL | 14,383,173 | 13,702,207 | 11,086,950 | 11,954,902 |
| Phenolic and Other Tar-Acid Resins: | | | | |
| Molding materials[1] | 18,355,995 | 18,032,946 | 18,902,397 | 16,847,539 |
| Bonding and adhesive resins for— | | | | |
| Laminating (except plywood) | 6,236,134 | 4,163,799 | 6,179,248 | 3,952,169 |
| Coated and bonded abrasives | 1,324,410 | 1,260,751 | 1,357,589 | 1,259,805 |
| Friction materials (brake linings, clutch facings, and similar materials) | 1,403,771 | 1,248,436 | 1,402,988 | 1,201,523 |
| Thermal insulation (fiber glass, rock wool) | 4,617,108 | 4,624,227 | 4,635,785 | 4,498,228 |
| Plywood | 4,923,204 | 4,248,878 | 5,085,785 | 4,181,339 |
| All other bonding and adhesive uses | 4,602,822 | 5,257,672 | 5,629,897 | 5,203,648 |
| Protective-coating resins unmodified and modified except by rosin | 2,631,590 | 2,273,011 | 2,403,873 | 1,846,133 |
| Resins for all other uses | 3,479,973 | 3,219,180 | 3,374,067 | 2,923,117 |
| TOTAL | 47,575,007 | 44,328,900 | 48,870,913 | 40,913,501 |
| Urea and Melamine Resins: | | | | |
| Textile-treating and textile-coating resins | 2,921,520 | 2,691,119 | 2,716,023 | 2,521,309 |
| Paper-treating and paper-coating resins | 2,658,148 | 1,213,364 | 2,569,973 | 2,477,387 |
| Bonding and adhesive resins for— | | | | |
| Laminating | 3,135,166 | 2,368,058 | 2,961,154 | 2,425,112 |
| Plywood | 10,498,696 | 10,404,561 | 9,868,100 | 10,113,337 |
| All other bonding and adhesive uses | 1,543,227 | 1,401,573 | 1,425,531 | 1,106,644 |
| Protective-coating resins, straight and modified | 3,364,146 | 2,351,243 | 3,170,084 | 2,388,066 |
| Resins for all other uses, including molding | 10,808,645 | 10,343,836 | 10,829,049 | 10,986,928 |
| TOTAL | 35,229,548 | 31,773,754 | 33,539,914 | 32,018,783 |
| Styrene Resins: | | | | |
| Molding and extrusion materials: | | | | |
| Straight polystyrene | 20,175,267 | 20,690,784 | 25,753,619 | 21,772,194 |
| All other | 30,219,666 | 26,083,962 | 29,650,355 | 26,102,723 |
| Protective-coatings | 7,214,882 | 7,219,630 | 6,818,607 | 6,277,379 |
| Textile and paper treating and coating resins | 4,488,739 | 3,955,603 | 5,419,653 | 4,179,828 |
| All other uses | 12,741,318 | 16,729,365 | 13,091,074 | 16,084,116 |
| TOTAL | 74,839,872 | 74,589,344 | 80,733,308 | 74,416,240 |
| Vinyl and Vinyl Chloride Resins:[2] | | | | |
| Polyvinyl chloride and copolymer resins (50% or more PVC) for— | | | | |
| Film (resin content) | | 7,526,277 | | 6,765,014 |
| Sheeting (resin content) | | 10,390,106 | | 10,664,310 |
| Molding and extrusion (resin content) | | 27,226,022 | | 25,560,777 |
| Textile and paper treating and coating (resin content)[3] | | 5,951,090 | | 6,466,340 |
| Flooring (resin content) | | 14,095,951 | | 13,761,582 |
| Protective coating (resin content) | | 3,038,020 | | 2,582,932 |
| All other uses (resin content) | | 8,375,597 | | 7,613,803 |
| All other vinyl resins for— | | | | |
| Adhesives (resin content) | | 5,182,241 | | 4,661,984 |
| Protective coatings (resin content) | | 2,462,346 | | 2,797,329 |
| All other uses (resin content) | | 12,819,162 | | 11,175,006 |
| TOTAL | 92,122,461 | 97,066,812 | 98,883,985 | 92,049,077 |
| Coumarone-Indene and Petroleum Polymer Resins | 21,133,287 | 21,123,145 | 21,281,046 | 20,563,036 |
| Polyester Resins: | | | | |
| For reinforced plastics | 13,659,541 | 12,090,996 | 12,361,468 | 11,725,040 |
| For all other uses | 2,031,911 | 1,911,696 | 1,706,586 | 1,724,673 |
| TOTAL | 15,691,452 | 14,002,692 | 14,068,054 | 13,449,713 |
| Polyethylene Resins: | | | | |
| For film and sheeting | | 33,854,174 | | 29,231,539 |
| Molding materials | | 19,658,059 | | 18,380,484 |
| Extrusion materials | | 9,234,939 | | 10,115,473 |
| For all other uses | | 34,260,508 | | 34,852,252 |
| TOTAL | 98,311,812 | 97,007,680 | 104,549,169 | 92,579,748 |
| Epoxy Resins: | | | | |
| For protective coatings | | 1,740,903 | | 1,712,211 |
| For all other uses | | 2,101,918 | | 1,913,744 |
| TOTAL | 4,579,149 | 3,842,821 | 3,963,303 | 3,625,955 |
| Miscellaneous Synthetic Plastics and Resin Materials, Including Silicone Resins | 21,323,984 | 18,879,504 | 20,228,550 | 17,770,076 |
| GRAND TOTALS | 425,189,745 | 416,316,859 | 437,205,092 | 399,341,031 |

[1] Includes fillers, plasticizers, and extenders.
[2] Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3] Includes data for spreader and calendering-type resins.
SOURCE: United States Tariff Commission, Chemical Division.

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*News about*

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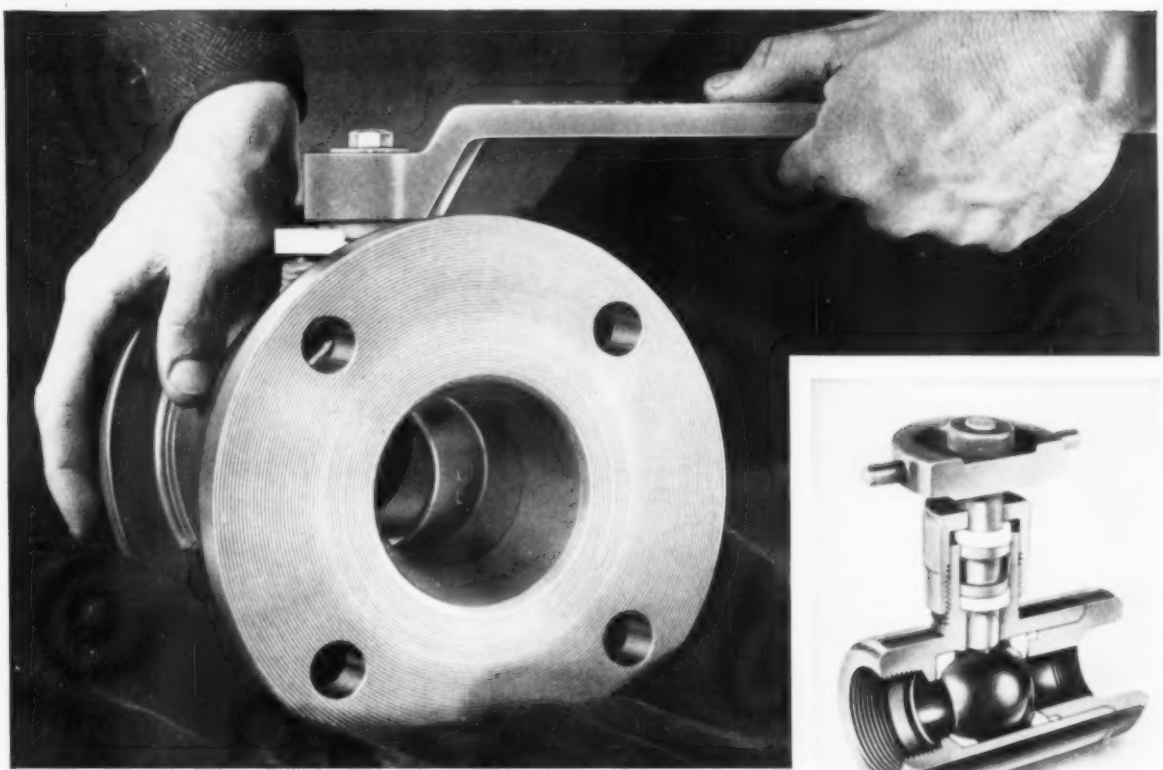

*Valves by Jamesbury Corp., Worcester, Mass. Geon rigid vinyl parts molded by Mannesman-Easton Plastic Products, Inc., Easton, Pa. Valves in sizes from 1/2" to 4", shown in large photograph, are rated at 150 psi to 100 F. and at 50 psi to 130 F. They can be remote operated. B.F.Goodrich Chemical Company supplies the Geon rigid vinyl material only.*

## New ball valve of Geon helps piping systems fight corrosion

Thousands of test cycles with this new valve made from Geon rigid vinyl have proved the effectiveness of its seal, either at full pressure or vacuum. Since it is made entirely of Geon except for seats and seals, it offers pipe users another weapon for the battle against corrosion. Geon offers superior resistance to oils, acids, alkalies and most chemicals.

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Geon offers remarkably varied opportunities for products that open new markets or improve present applications. In rigid form it is being used for pipe, window frames and ductwork . . . in other forms for weatherstrip, wall coverings, foam products, or coatings for metal, paper or textiles. One member of the Geon family can surely help you make a better product. Write for information to Dept. AH-4 B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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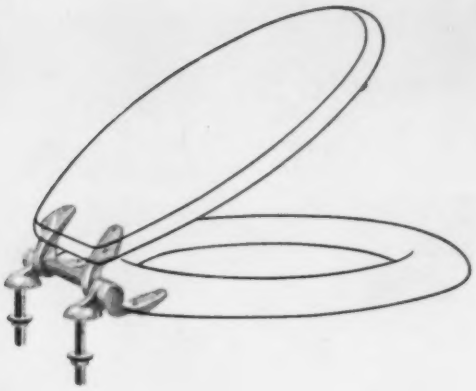

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**"We picked MARLEX rigid polyethylene for this component because it combines economy with all of the qualities needed in a hinge of this type . . . toughness, unbreakability, resistance to corrosion and bacteria . . . self-lubrication, rigidity, hard glossy surface and colorability."**

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*No other type of material serves so well and so economically in so many different applications. How can MARLEX serve you?*

*MARLEX is a Trademark for Phillips family of olefin polymers.

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